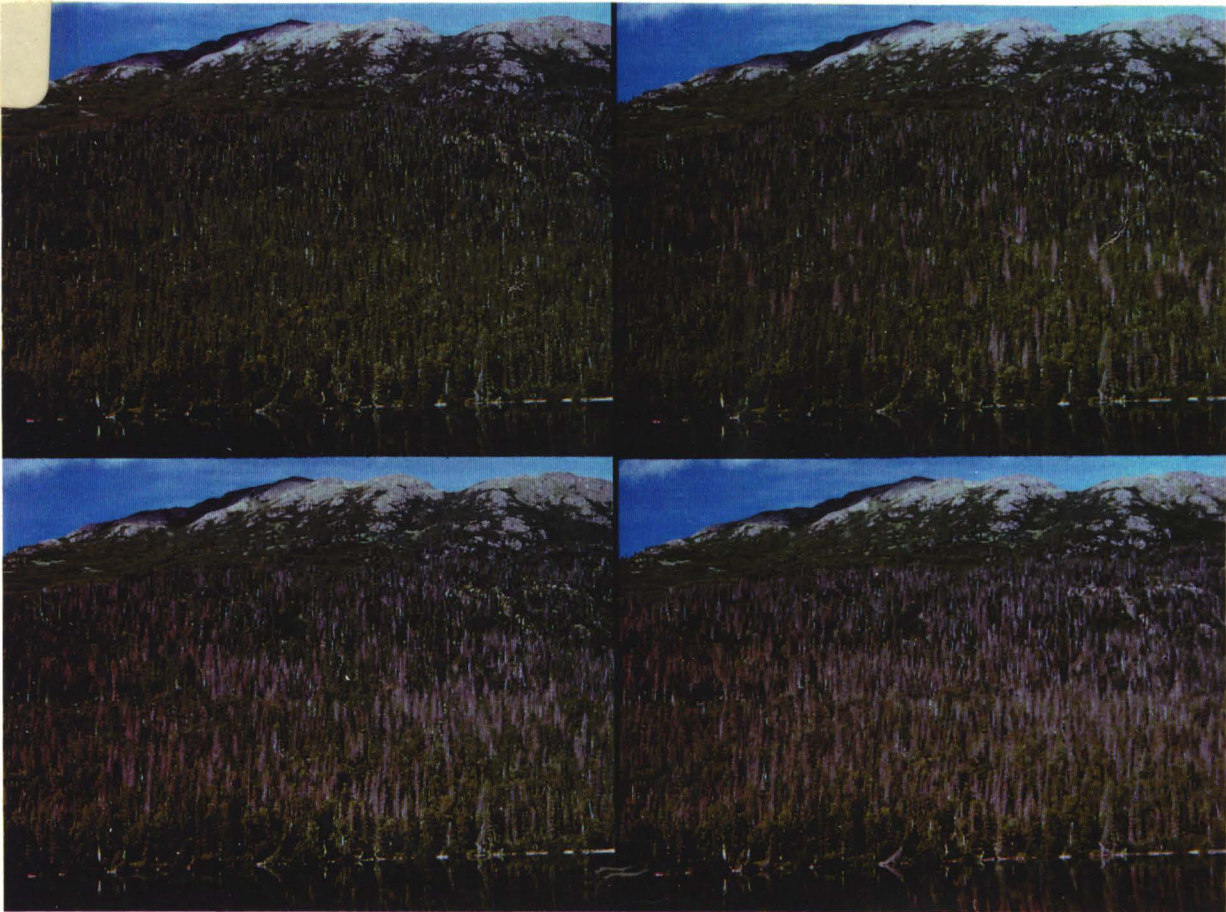


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PUBLIC PERCEPTION AND ATTITUDES REGARDING SPRUCE BARK BEETLE DAMAGE TO FOREST RESOURCES ON THE CHUGACH NATIONAL FOREST, ALASKA

Final Report December 1992

prepared for:
USDA Forest Service
Forest Pest Management
Region 10

Terry C. Daniel
Psychology and Renewable
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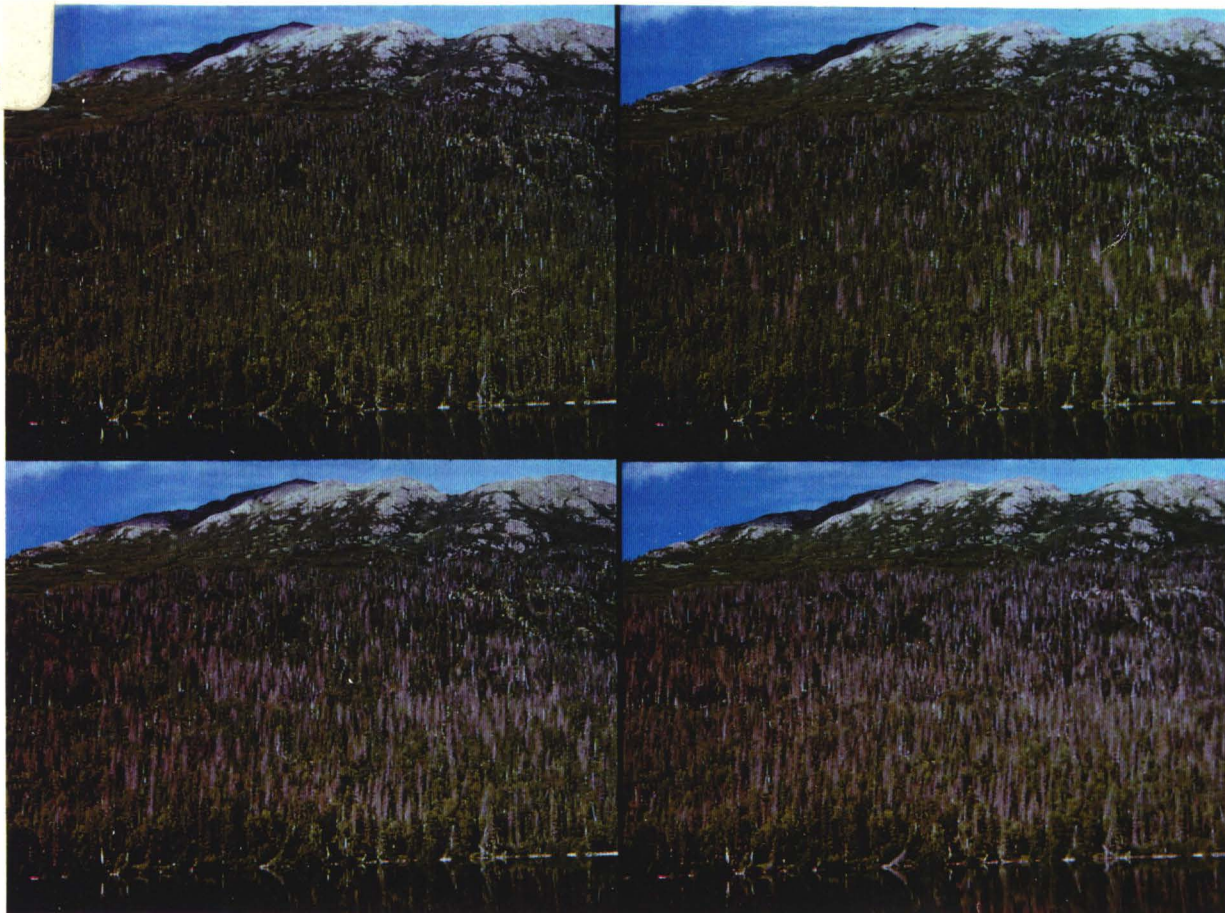
Jeanine L. Paschke
Landscape Architecture
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ACKNOWLEDGEMENTS

The authors wish to thank Ed Holsten and Gene Lessard, Forest Pest Management, Region 10, USDA Forest Service, for their excellent cooperation and important contributions to this research. We are also grateful to the many members of the Chugach National Forest staff, the Alaska State Forest Service and local Borough foresters who gave unselfishly of their time and talents to assist this project. Jack Kruse, Institute of Social and Economic Research, University of Alaska Anchorage, collaborated by including a sample of our digital images in his Alaska State telephone survey and by sharing data and ideas during the course of our project.

The continuing support of Bill White, Methods Applications Group, Forest Pest Management, USDA Forest Service is also gratefully acknowledged.

Finally, a very special thanks is extended to the citizens of the Kenai Peninsula who invited us into their communities and recruited their neighbors and friends to participate in this assessment.

EXECUTIVE SUMMARY

The spruce bark beetle outbreak on the Kenai Peninsula, Alaska, poses a continuing threat to internationally significant scenic and recreational resources. Reported here are the results of an assessment of perceptually preferred forest conditions and acceptable forest management policies as judged by residents and visitors in the affected area.

Computer visual simulations were employed to depict a range of forest conditions projected to occur over the next 50 years as a result of bark beetle infestation. Conditions expected to result from alternative forest management actions were also simulated for comparison. Respondents rated individual simulated scenes for *natural scenic beauty* or selected between pairs of four-scene scenarios that depicted expected outcomes of **treatment vs no treatment** options for representative forest scenes.

Alternative management strategies were described and respondents rated the relative acceptability of (or their agreement with) each. Management options assessed included **general policies**, methods for **prevention** of future beetle outbreaks, **protection** of threatened stands during outbreaks, **restoration** of stands already affected and **expectations** for continuing spread of the current outbreak. Principal findings of the assessment included:

Sight-seeing was the predominant activity for visitors and *views of natural scenery* and *viewing wildlife* were the most important factors affecting the quality of their trip to Alaska.

Residents were very much aware of the bark beetle outbreak and reported *loss of scenic beauty* and *increased fire danger* as the most important impacts.

Based on computer simulations of forest scenes, residents' and visitors' **scenic beauty ratings** were highly consistent and significantly declined as the proportion of beetle-killed trees in the scene increased.

Respondents consistently preferred four-scene scenarios depicting forest conditions projected for **treatment** options over those for **no treatment**. A preventative **thinning** scenario was preferred to **no treatment** for threatened stands, and **cut/leave/burn** was the most preferred restoration scenario for stands with high beetle-caused tree mortality.

A substantial majority of respondents rejected *let nature take its course* as a policy for areas *near* developments where beetle effects were *more severe*; this policy was most acceptable for areas *far* from developments where effects were *less severe*.

Thinning was preferred over *clear cutting small patches* as a method for **prevention** of beetle outbreaks, and residents agreed that *cut trees should be sold to private companies* even when *selling the trees will only pay part of the costs*.

The use of "environmentally approved" *insecticides* for **protection** of selected trees during an outbreak met with divided responses; the number "strongly agreeing" was essentially matched by the number "strongly disagreeing."

Restoration of areas already severely affected by bark beetles was a high priority for respondents and generally treatments that produced more rapid regeneration of spruce forests were preferred; *cut/remove/burn* (moderately hot fire) was the most preferred option, followed by *cut/remove/scrape* (mechanical scarification), with *leaving the forest undisturbed* least preferred. The use of "environmentally approved" *herbicides* produced strong responses almost equally split between support and non-support.

Respondents' expectations were that the outbreak *will continue to spread*, including *to their own properties*, and that the effects will be severe, *at least half of the spruce trees will die* in affected areas.

Over 65% of respondents disagreed with *allow(ing) most of the spruce trees in your area to be killed by bark beetles (rather) than to have the forest treated by cutting and spraying insecticides*.

The strongest differences among respondents were with respect to the use of insecticides and herbicides: Supporters of *chemical treatments* agreed that *spraying insecticides is the best way to protect large trees near homes*; that sprayed trees are *essentially 100% safe from beetle attack*; that *approved insecticides are safe* and they *would be willing to use* them; and supported *applying environmentally approved herbicides* to restore spruce in damaged areas. At the same time, supporters tended to disagree that *other insects and animals might be harmed*, that insecticides are *potentially dangerous to humans* and that *herbicides should not be used under any circumstances because of possible contamination of the environment*. Non-supporters of *chemical treatments* exhibited the opposite pattern of agreement/disagreement.

To be consistent, respondents who exhibited perceptual preferences for particular forest conditions should have supported management policies required to achieve those conditions. However, no consistent relationships were found between preferred perceptual *ends* and supported management *means*; preferences for forest conditions produced by *treatment* were not consistently associated with support for active management policies implied by those preferences.

In conclusion, results indicated that bark beetle-caused tree mortality has significantly reduced scenic beauty of forest scenes in the Kenai Peninsula study area. Future forest conditions resulting from active management policies were consistently preferred over conditions projected for non-intervention alternatives. There was substantial public support for active management response to the spruce bark beetle outbreak, but there was no clear consensus for any particular management strategy. The greatest divisions among the sampled publics revolved around the use of *chemical treatments*, with much of the controversy based on differing beliefs about the effectiveness of insecticides and the severity of environmental hazards associated with both insecticides and herbicides.

Forest managers can expect substantial public support for actions designed to protect or restore scenic values, but a concerted public information/environmental education program should be an important precondition for any application of insecticides or herbicides.

PUBLIC PERCEPTION AND ATTITUDES REGARDING SPRUCE BARK BEETLE DAMAGE TO FOREST RESOURCES ON THE CHUGACH NATIONAL FOREST, ALASKA

The spruce bark beetle outbreak on the Kenai Peninsula, Alaska, has had effects on timber resources and on the habitat of some wildlife species. In some areas, wildfire hazard has increased. As the outbreak and its aftermath continues there will be further effects on natural resources important to local communities, the state of Alaska and the nation.¹

Unequaled scenic landscapes and outstanding recreational opportunities are among Alaska's most important natural resources, and these resources are among those most directly at risk from the spreading beetle outbreak. Management response to the outbreak must, therefore, address the protection and rehabilitation of scenic and recreational resources in affected areas. However, choosing the best management strategies is complicated by the fact that significant parts of the affected area are highly visible to the public. Moreover, Alaska, and the Kenai Peninsula in particular, is the focus of considerable concern by local and national constituencies which often have conflicting goals. Thus, management direction must be carefully designed to be effective and efficient in ecological and economic terms, and at the same time responsive to the perceptions, attitudes and values of the various local and national publics that have a stake in the outcome.

The assessment presented in this report focussed on determining public perceptions of the effects of the spruce bark beetle outbreak

on forest scenic values, and on gauging public attitudes toward alternative forest management approaches. Participants for the studies were sampled from residents, visitors and tourists in and near the affected areas of the Kenai Peninsula. Computer generated visual simulations of forest scenic vistas were employed to assess public perception of insect-affected (or threatened) areas, and to determine preferences for possible alternative future forest conditions. Additional questions investigated participants' attitudes toward different insect-targeted management strategies associated with the simulated forest conditions.

Results from two studies are reported. The first study, conducted in the summer of 1990, primarily addressed bark beetle effects on tourists' perceptions of forest *scenic beauty*. A small number of Alaska residents were also sampled, and their attitudes and values associated with the insect outbreak and with alternative management strategies were explored. The second study, in the summer of 1991, focussed on residents of Kenai Peninsula communities directly affected or threatened by the spreading bark beetle outbreak. The primary objective of the second study was to further articulate residents' perceptions of alternative future forest conditions, and their attitudes toward alternative forest management approaches for the *prevention* of outbreaks, the *protection* of stands during outbreaks and the *restoration* of areas already affected by outbreaks.

STUDY APPROACH

Public perceptions of alternative future forest conditions were assessed by having samples of residents and visitors view and rate the *scenic beauty* of forest scenes sampled from bark-beetle affected forest areas on the Kenai Peninsula. Scenes represented the full range of outbreak conditions, from sites with no detectable effects to sites where virtually all of the trees in the scene were dead.

Digital video imaging techniques² were used to create simulations of future (hypothetical) forest conditions for a representative sample of scenes. These simulated scenes allowed experimentally controlled manipulation of specific forest features expected to change as a result of the bark beetle infestation and associated management options. This procedure insured that only selected features of the scenes were changed, while other features not associated with the targeted beetle or management actions were held constant. Visual simulations representing expected consequences of alternative management actions (including no action) for up to 50 years into the future formed the basis for the public perceptual assessment process.

In conjunction with perceptual assessments, respondents also indicated opinions and

attitudes toward a variety of forest management practices associated with bark beetle outbreak prevention and control, and with restoration of forest stands after severe infestations. Issues addressed in this verbal component of the study included: public awareness of the bark beetle outbreak; values judged to be at risk; the perceived likelihood of the outbreak spreading; and the acceptability of several management options, including forest overstory manipulations by clear cutting or thinning, the use of insecticides, herbicides and fire, and "allowing nature to run it's course."

There was no effort to obtain formal random samples, but the study design allowed comparisons of the perceptions and attitudes of tourists/visitors and residents (1990 study), as well as comparisons among residents from different communities in affected and threatened areas on the Kenai Peninsula (1991 study). The relationships between perceptually preferred forest conditions, the desired *ends*, and the acceptability of the various management strategies required to achieve those conditions, the *means*, were also investigated.

RESPONDENTS

A total of 84 Alaska residents and 306 visitors participated in the 1990 study. Participants were recruited at shopping centers and at major tourist/recreation facilities in the Anchorage/Kenai Peninsula study area. The visitor sample included participants from a wide geographic area in the US and abroad. Most of the residents in this "convenience

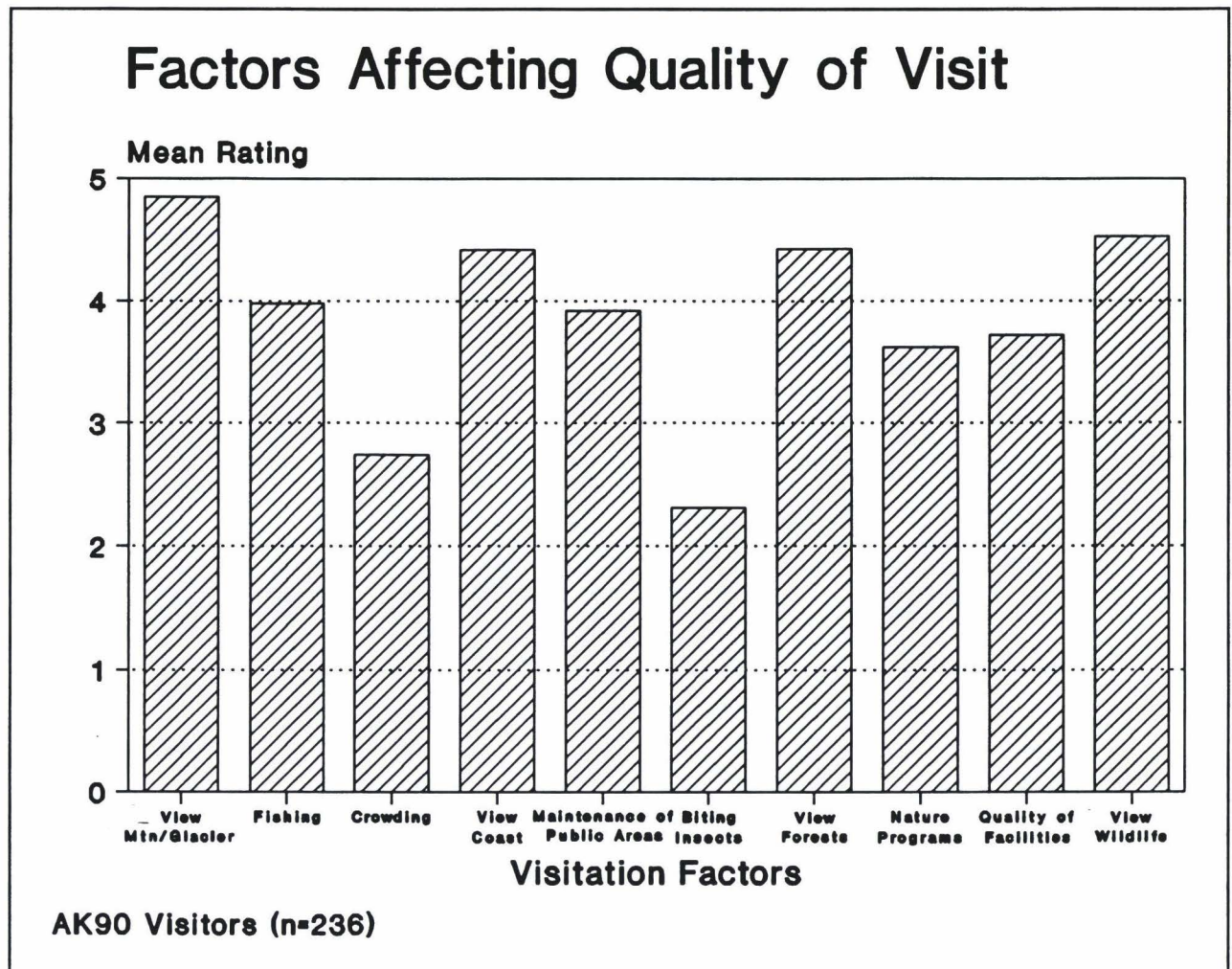
sample" were from the Anchorage area, with smaller numbers from Kenai Peninsula communities.

The 306 visitors represented many of the lower 48 states and several foreign countries. Most of the visitors (73%) were in Alaska for the first time, 94% planned to stay a week or

more, and 50% were staying three weeks or more. Planned activities included *sight-seeing* (94%), *wildlife viewing* (75%), *hiking* (61%), *camping* (49%) and *fishing* (47%). Factors reported as having the greatest positive effect on the quality of the visit were (in order of rated importance): *viewing mountains and glaciers*, *viewing wildlife*, *viewing forest scenery*, and *viewing coastal scenery*. *Quality of fishing* was reported as either irrelevant or mildly positive for most

visitors. The most negative factor reported was *biting insects*.

For the 1991 study 166 residents were recruited through civic organizations in targeted Kenai Peninsula communities. Participants responded individually to sets of color prints depicting alternative conditions for representative forest scenes and to management policy questions bound in "photo album" booklets. Participating groups ranged in size from 5 to 35 people.



Awareness of the spruce bark beetle outbreak was very high among respondents in both the

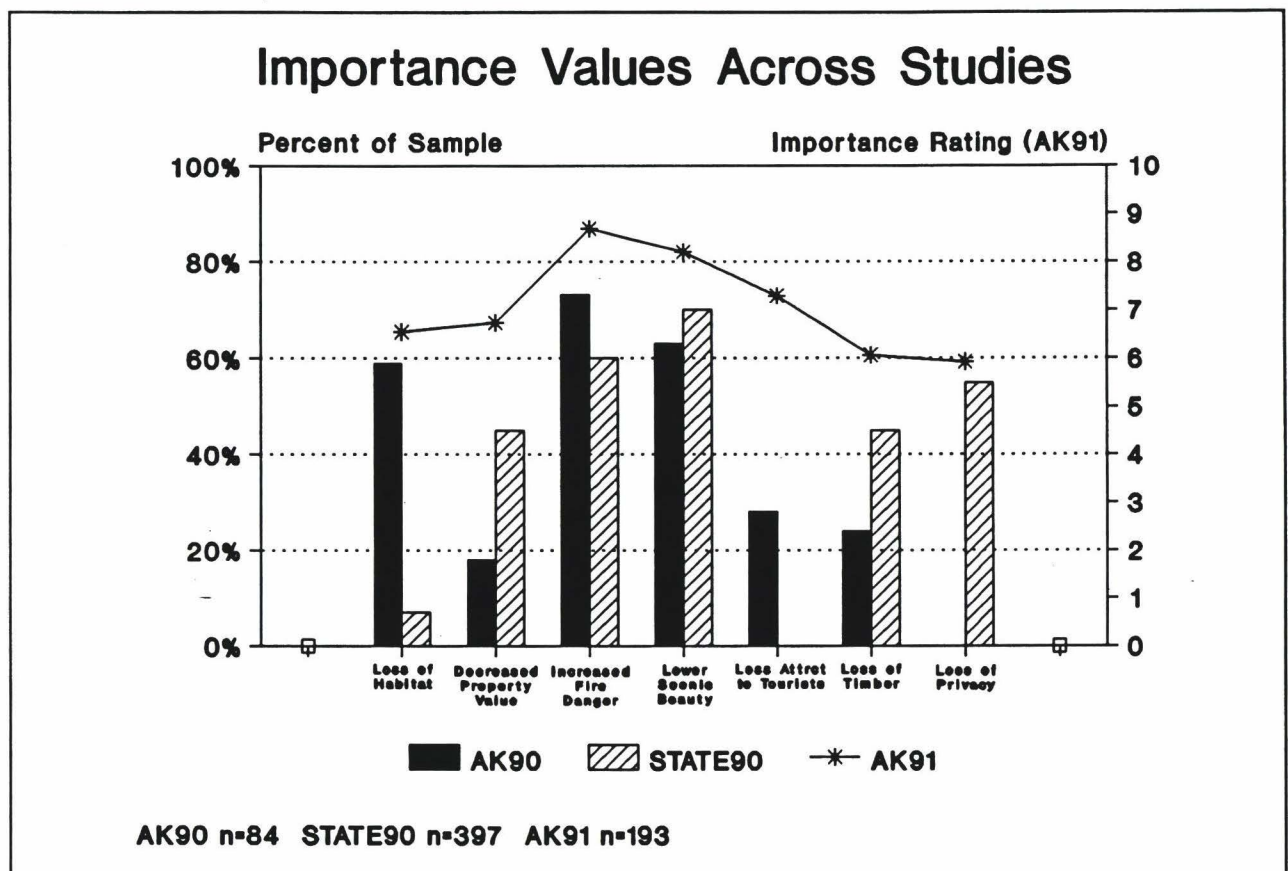
1990 and 1991 studies. Of the residents sampled in 1990, 73% reported *noticing dead*

trees and 80% reported that they were aware of the outbreak prior to the study. For the resident sample in the 1991 study, 58% reported noticing dead trees near their own community and 79% noticed dead trees elsewhere on the Kenai. Over 80% reported being aware of the spruce bark beetle outbreak prior to the study. These results are very consistent with the Alaska State random telephone survey,³ where an astonishing 88% of Kenai Peninsula residents cited "dying trees" or "beetles killing trees" in response to an open-ended question regarding the most serious problems with forests on the Peninsula.

For residents in the 1990 study the most important effects of the outbreak were

increased fire danger, loss of scenic beauty, and loss of wildlife habitat. Less important effects were decreased property values, decreased attractiveness to tourists and loss of timber values.

The 1991 study produced essentially parallel results; effects rated most important were increased fire danger, loss of scenic beauty, and lower attractiveness to tourists. Judged less important were loss of privacy, loss of timber values, loss of wildlife habitat and loss of property values. The same basic pattern of concerns was also found in the Alaska State survey; loss of scenic beauty (70%), increasing fire danger (60%), loss of privacy (55%), loss of timber values (45%), decrease in property values (45%) and loss of wildlife habitat (4%).



Demographics - 1990/1991

1990 Residents		1990 Nonresidents		1991 Residents	
Anchorage	111	California	45	Ninilchik	34
Wasilla	17	Washington	22	Kenai C.C.	26
Eagle River	12	Oregon	19	Cooper Landing	25
Soldatna	11	Florida	15	Anchor Point	21
Fairbanks	6	Canada	13	Hilltop Youth	20
Kenai	5	Michigan	13	Kasilof	12
Girdwood	5	New York	13	Homer	10
North Pole	3	Minnesota	12	Salamatof	8
Homer	3	Arizona	10	Ninilchik Native	5
Sterling	3	Indiana	10	Association	
Other	27	Other	122		
Total	203	Total	306	Total	161

Summary

Most visitors to the Kenai Peninsula were there for the first time, as is typical of many major tourist destinations, and they stayed for a considerable period of time, most planning stays of one to three weeks. Sight-seeing and wildlife viewing were the dominant activities reported, and spectacular natural scenery was the most important factor contributing to the enjoyment of the visit. The emphasis on viewing scenery clearly justifies forest managers' concerns about spruce bark beetle effects on visual/aesthetic resources in the area.

Residents in both the 1990 and 1991 studies were very much aware of the spruce bark beetle outbreak and its effects. Reports in the media, special government bulletins and meetings, as well as direct observation all contributed to the high awareness levels.

Major areas of concern to residents were the loss of natural scenic beauty and increased fire danger, with lesser concern expressed for loss of timber values and wildlife habitat. Based on these findings, forest management policies directed at protecting or restoring scenic values and reducing risk of wildfires should be supported by Kenai Peninsula residents.

VISUALIZING FUTURE FOREST CONDITIONS

The visual effects of the spruce bark beetle outbreak on the Kenai Peninsula were represented by a sample of over 500 color slides of forest vistas collected in the summers of 1989 and 1990. View points were sampled from along roads and trails, and within designated campgrounds frequented by visitors to the area as well as from locations within and near developed communities. Slides depicted dramatic as well as common (for Alaska) scenes of forested areas, and included bark beetle impacts ranging from undetectable to essentially 100% tree mortality.

Typical of the study area, over half of the scenes included either lakes or streams, and many exhibited a backdrop of high peaks, some with caps or patches of snow. Scenes dominated by development features (roads, buildings, disturbed areas) were excluded from the sample. A representative subset of the scenes, all meeting high standards of photographic quality, were selected as the basis for the public perception studies.

Digital Video Image Processing

All color slides selected for inclusion in the study were commercially scanned to produce digital computer files. This process allows translation of the color slide into a high resolution image (up to 512 by 482 lines) with over 32,000 different levels of color. When these images are displayed on high quality video monitors, or output as color slides or prints, the quality of the image is essentially equal to that of a good color photograph.

There are several important advantages of the

digital format. First, the computer image can be quantitatively analyzed to determine precisely differences in color and other characteristics of features in the scene, e.g., differences between hardwoods and conifer trees, or between living and dead spruce trees. Second, selected features of the scene can be systematically altered to represent changes projected to occur as a result of insect infestation or of forest management activities.

For example, if increasing tree mortality is projected for selected areas in a forest scene, green trees can be "killed" by applying color "filters" to shift their color values from living green to the reddish or grey colors typical of beetle killed trees. If some trees are to be removed or some area is projected to burn, existing trees in that region of the scene can be "cut" out of the scene and replaced by "pasting" in appropriate open or burned area textures. Examples are shown in the color illustrations.

Simulations of the forest conditions that were the focus of the perceptual assessments reported here were developed at the Imaging Systems Laboratory at the University of Illinois. A combination of geographic information system view-modeling techniques and customized digital video image editing routines were used.⁴ Different levels of insect damage and a number of alternative future forest conditions associated with selected management scenarios were simulated using image processing and pattern substitution techniques developed for this purpose. Digital image files for unaltered and for simulated scenes were used to produce color prints and slides, or they were directly displayed on a

high quality color video monitor. All representations achieved near photographic quality levels for color, resolution and realism.

Selection of representative scenes and the detailed features of each simulation were guided by available forest inventory data, maps of stand boundaries, computer generated "perspective views" and by the expert judgements of forest silviculturalists and pest management specialists working in the area. In addition, the members of a multi-disciplinary citizen/professional panel charged with planning forest management responses to the bark beetle outbreak in the Cooper Landing study area served as expert judges for selecting representative forest scenes, and for validating the simulations of hypothetical forest conditions.

Alternative Future Conditions

Using the selected representative scenes as a starting point, two general types of "future forest" scenarios were created. Some scenarios depicted changes in forest scenes expected to occur over time as a result of a continuing bark beetle infestation, either assuming some preventative actions (e.g., thinning the susceptible spruce trees) or that no action was taken. The *no treatment* scenarios extended from "green" scenes, where very few or no dead trees were detectable, and progressed through scenes of intermediate stages to a condition where virtually all of the spruce trees in the scene were dead.

The infestation scenarios were created retrospectively, beginning with scenes of dead trees and using historic data to progressively "green up" the scene until it appeared as it did

prior to the infestation (see color Plates 1 - 3a). Other scenarios were created to depict future conditions expected to occur over a 50-year period as a result of a number of different forest management actions that might be taken to restore areas already severely affected by the bark beetle infestation (color Plates 4 - 9).

Six *base* scenes were selected for modification to represent expected changes in forest characteristics relevant to the spruce bark beetle outbreak. Four of the base scenes were manipulated (retrospectively) to develop scenarios reconstructing the progressive changes that had occurred over the preceding twelve years of the outbreak. Beginning with the scenes as they appeared in the summer of 1990 (unaltered photographs showing over 90% mortality of spruce) simulations were constructed (nominally) representing how each of these four scenes looked 12, 9, 6 and 3 years in the past. These scenarios showed the typical progression from green forest to increasing numbers of dead trees. In addition, an alternative retrospective scenario was constructed covering the same time period for one of the scenes (Kenai River/Schooner Bend), but assuming that the affected stands had been thinned by removing 50% of the spruce (in two separate operations) and encouraging a mixed age forest with a greater proportion of hardwoods (see Plate 3b).

For the 1990 study four of the base scenes were manipulated to depict conditions expected to result at 5, 10, 20 and 50 years in the future from two alternative strategies for managing areas where spruce tree mortality was already severe (90% or more of spruce are dead). Strategies represented were; *no treatment*, postulating a moderately severe wildfire followed by unaided natural regeneration dominated by brush, grasses and

hardwoods; and a *treatment* scenario in which dead spruce trees were clearcut and removed followed by a prescribed "site preparation" burn to encourage spruce regeneration (Plates 4 - 7). All other features of the scenes were held constant.

For the 1991 study additional 5-to-50 year scenarios were developed for the Kenai Lake/Snug Harbor base scene. All scenarios postulated clearcutting of the dead spruce followed by:

1. a high intensity burn (achieved by felling and leaving the dead spruce), leading to better spruce regeneration with some hardwoods (Plate 8a);
2. a light intensity burn (after removing the dead spruce), leading to predominately grass and some hardwoods (Plate 8b);

3. no special site preparation or regeneration efforts (only normal disturbance that occurs from summer logging operations), leading to predominately grass with a few hardwoods (Plate 9a); or
4. mechanical ground scarification, leading to better spruce regeneration with few hardwoods (Plate 9b).

Two additional scenarios were developed for one *near-view* scene representing views within the forest canopy, as would be typical in campgrounds or along trails. The near-view scene modification techniques required extensive "cutting and pasting" and relied largely on an artistic process. These simulations were intended only as an exploratory effort not central to the present study and thus they are not shown in the illustrations.

Summary of Visual Simulations

Retrospective Scenarios

3-6-9-12 years

Plate

Jean Lake	* No Treatment	1
Kenai Lake/S. of Snug Harbor	* No Treatment	2a
Kenai Lake/Snug Harbor	* No Treatment	2b
Kenai River/Schooner Bend	* No Treatment	3a
	* Thinning	3b

Restoration Scenarios

5-10-20-50 years

Cooper Creek Campground	* No Treatment	5a
	* Cut-Remove-Burn	5b
Cooper Creek from Resurrection Pass Trail	* No Treatment	6a
	* Cut-Remove-Burn	6b
Kenai River/Schooner Bend	* No Treatment	4a
	* Cut-Remove-Burn	4b
Kenai Lake/Snug Harbor	* No Treatment	7a
	* Cut-Remove-Burn	7b
	* High Intensity Burn	8a
	* Moderate Intensity Burn	8b
	* Normal Ground Dist.	9a
	* Mech. Scarification	9b
Near-View/Campground	* No Treatment	not shown
	* Thinning/Insecticide	not shown

Public Perception and Attitudes Regarding Spruce Bark Beetle Damage to Forest Resources on the Chugach National Forest, Alaska

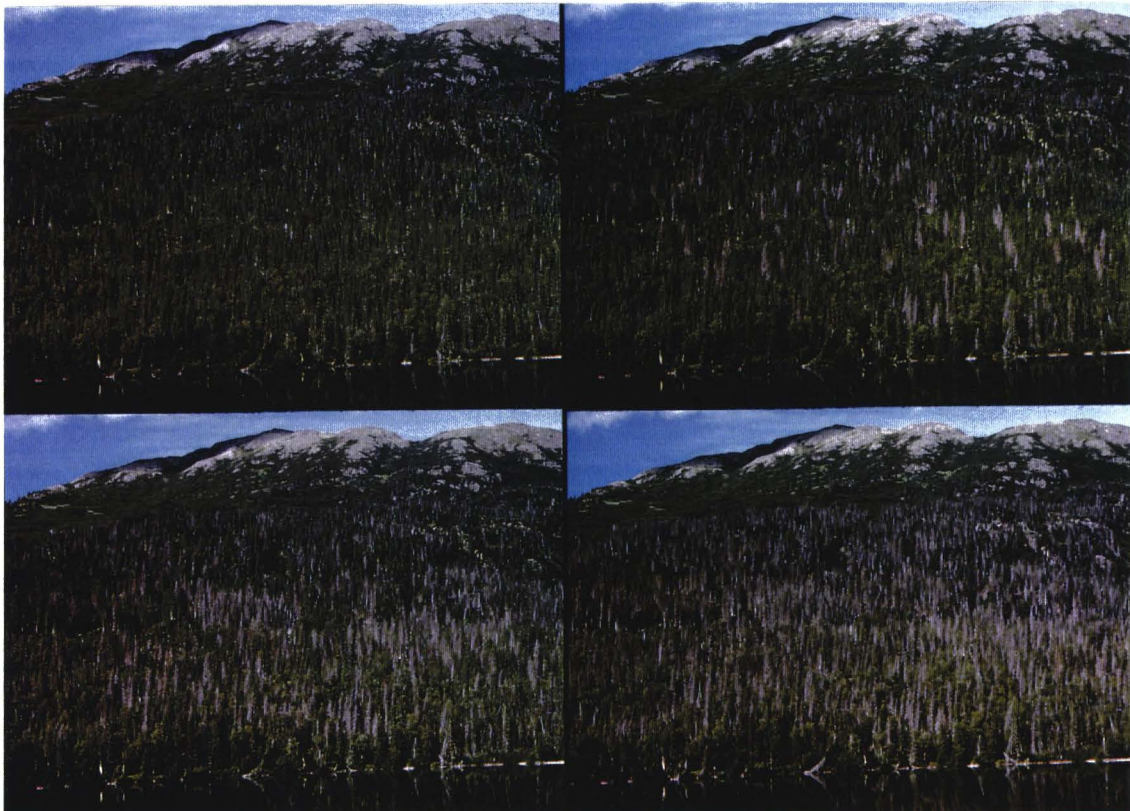
Color Plates

Each of the four-scene sets displayed in the following color plates shows simulations of the effects of a spruce bark beetle outbreak, or of a hypothetical forest management activity on a representative Kenai Peninsula forest scene. Simulations show progressive changes (3, 6, 9, 12 years for some scenarios and 5, 10, 20, 50 years for others) expected as a result of bark beetle infestation and/or some forest management activity. In each case, the image at the upper left represents conditions at the earliest time point (3 or 5 years) and the lower right represents the latest time period (12 or 50 years) after the postulated infestation or management action.

Plate 1

Jean Lake - Scene AJ 1319
3, 6, 9, 12 year scale

Simulations show progressive changes due to spruce bark beetle infestation with no management intervention. Simulations were created "retrospectively"; the year 12 (bottom right) representation shows the scene as it appeared in the summer of 1990.



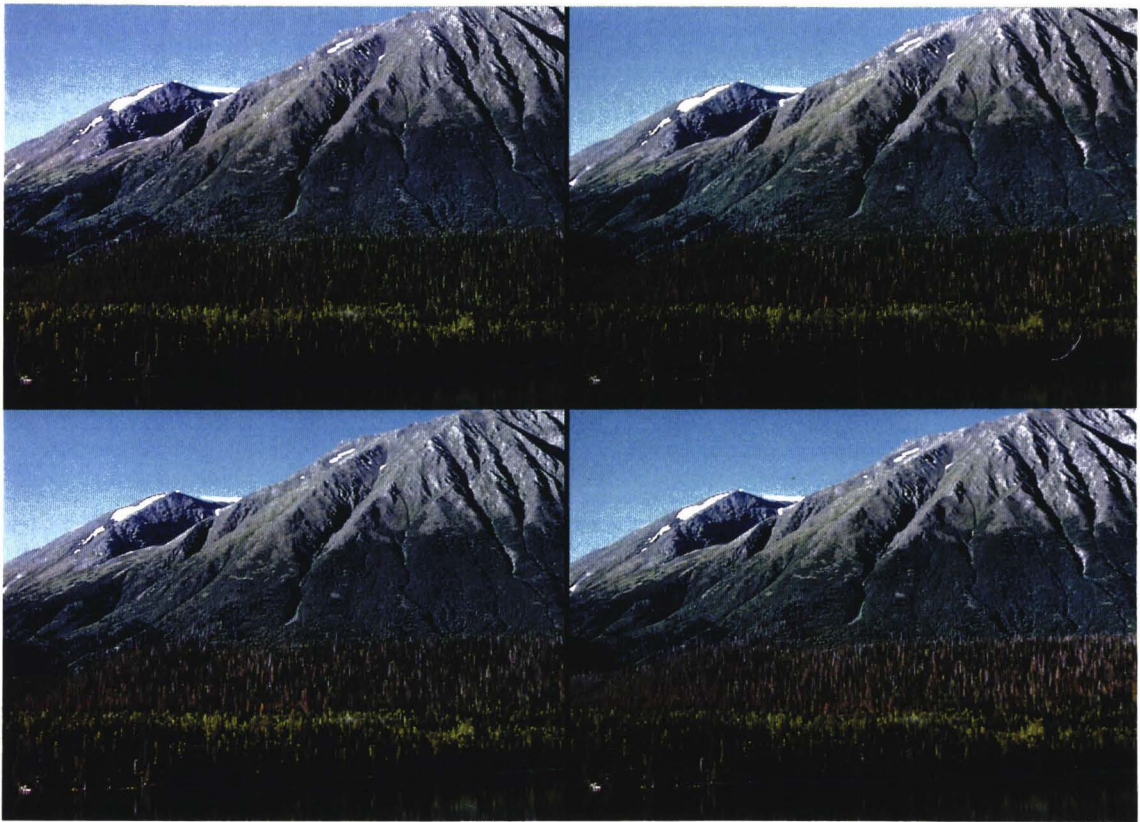


Plate 2a

Kenai Lake/South of Snug Harbor - Scene AI 1531
3, 6, 9, 12 year scale

Simulations show progressive changes due to spruce bark beetle infestation with no management intervention. Simulations were created "retrospectively"; the year 12 (bottom right) representation shows the scene as it appeared in the summer of 1990.

Plate 2b

Kenai Lake/Snug Harbor - Scene AI 1532
3, 6, 9, 12 year scale



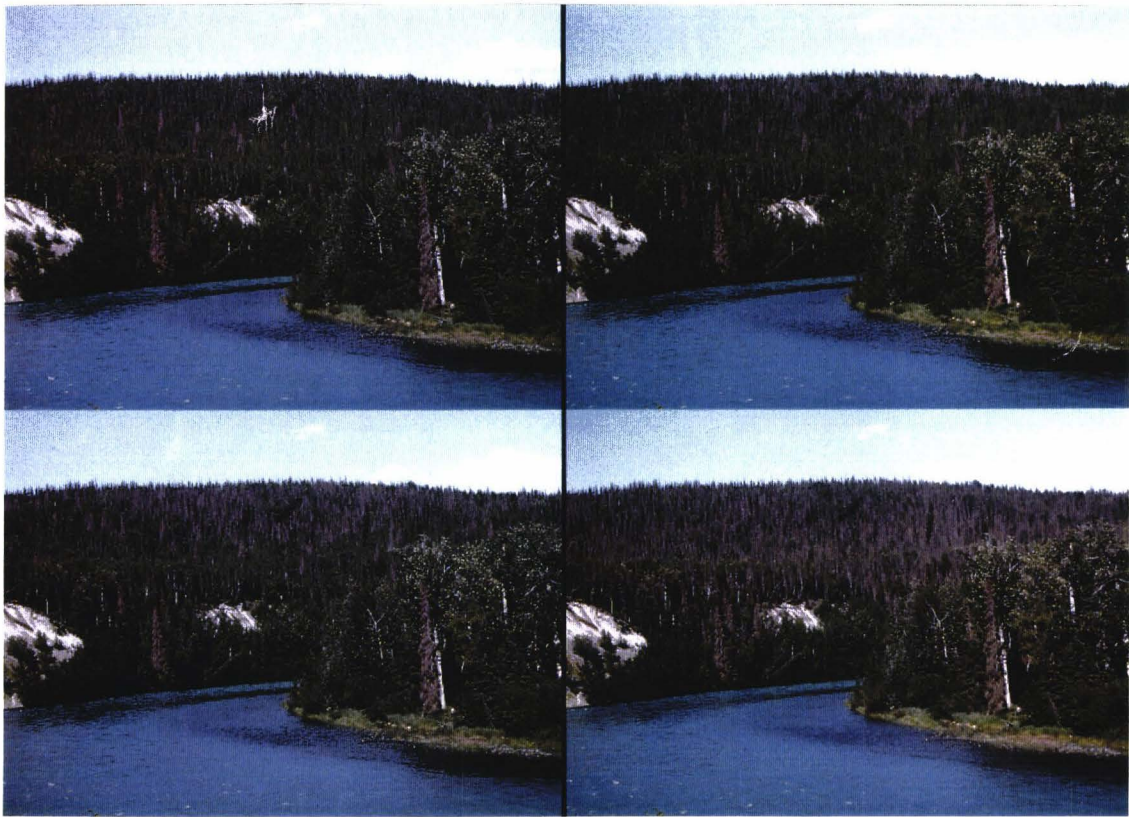
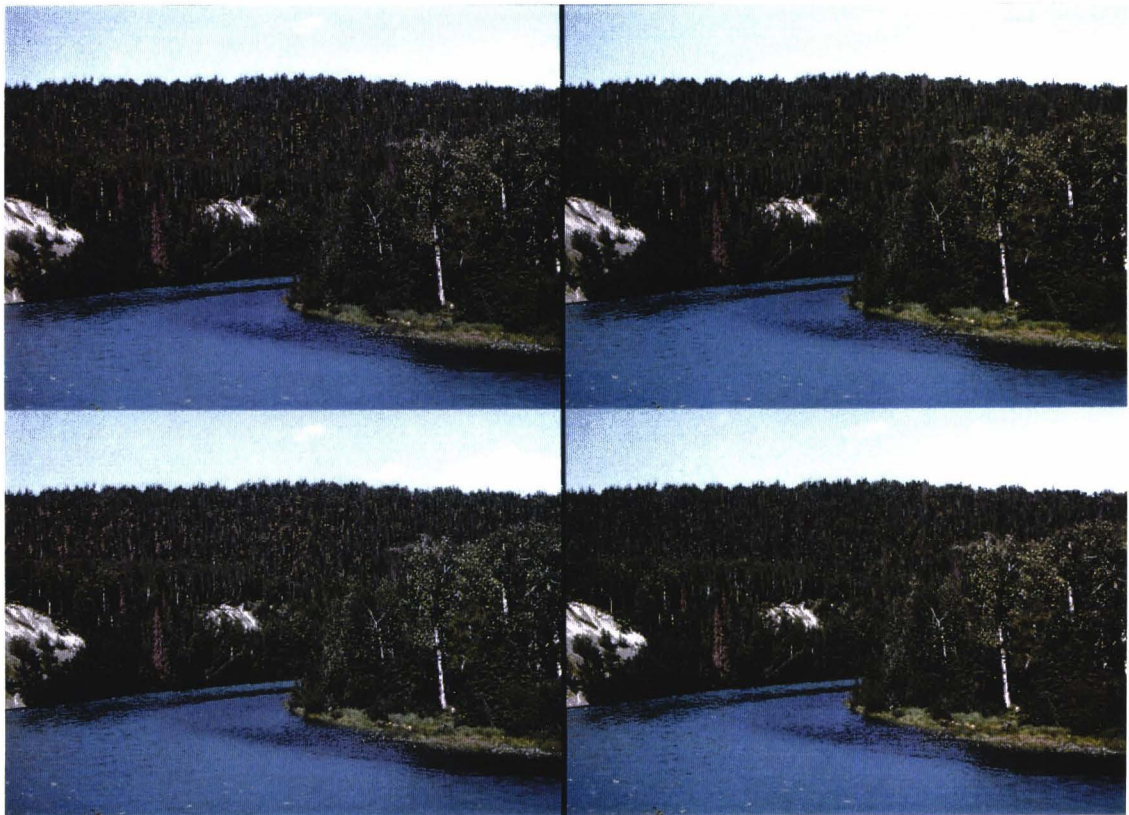


Plate 3a

Kenai River/Schooner Bend - Scene AI 0617
3, 6, 9, 12 year scale

Simulations show progressive changes due to spruce bark beetle infestation with no management intervention (Plate 3a). Plate 3b shows expected results following a pre-infestation thinning (at year 0) of susceptible spruce and subsequent thinning prior to year 9 (total thinning of 50%). The no-treatment simulations shown in Plate 3a were created "retrospectively"; the year 12 (bottom right) representation shows the scene as it appeared in the summer of 1990.

Plate 3b



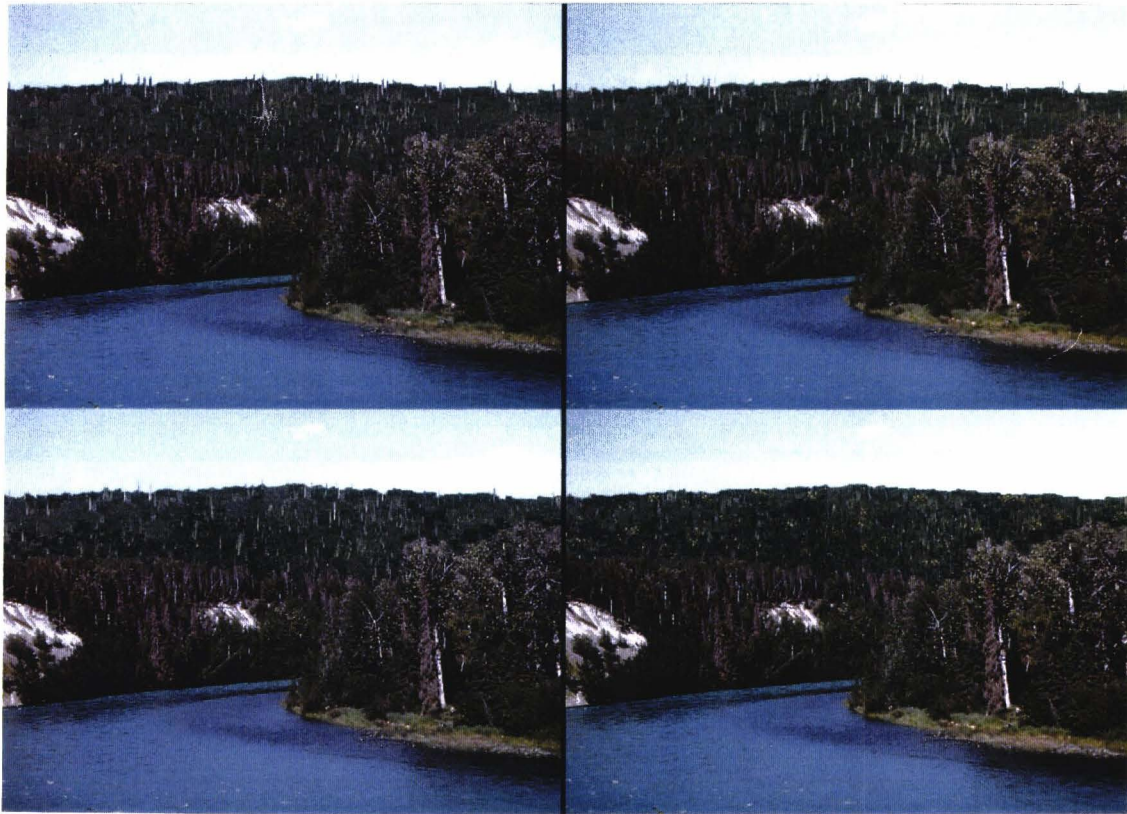
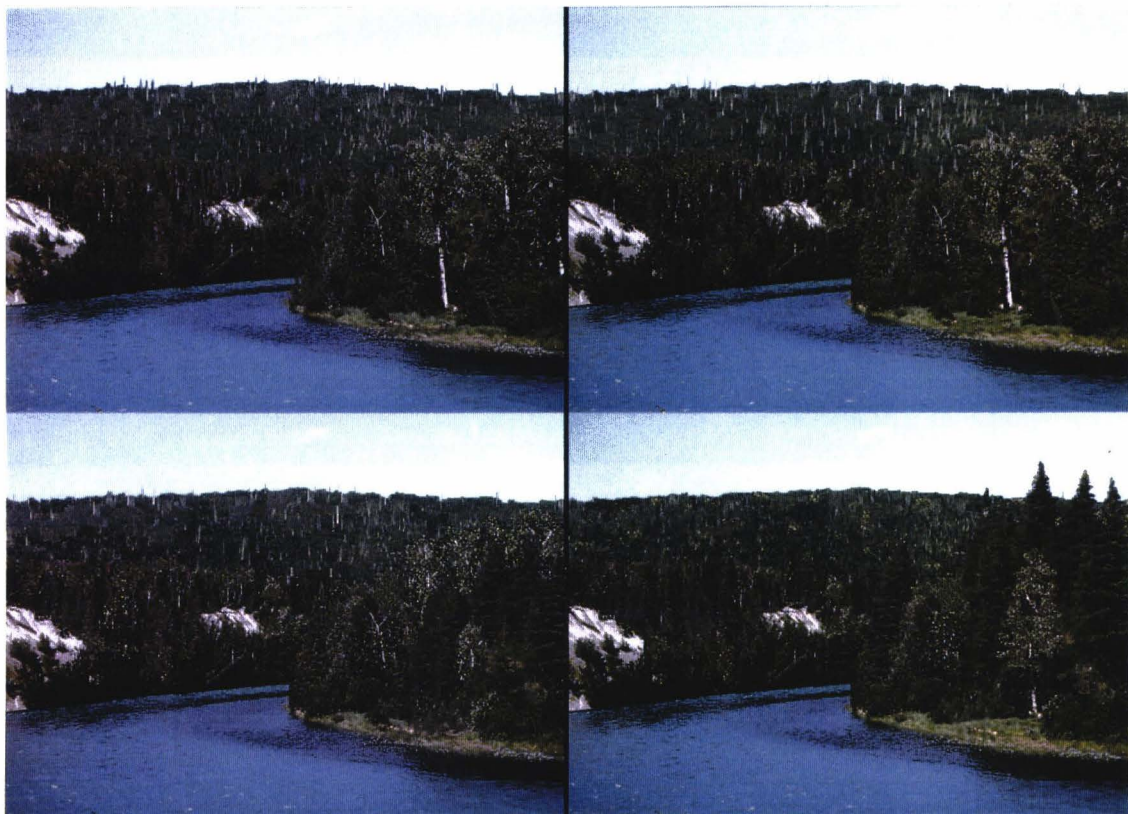


Plate 4a

Kenai River/Schooner Bend - Scene AI 0617
5, 10, 20, 50 year scale

Simulations show conditions as the forest recovers from a spruce bark beetle outbreak. In both cases, an anticipated wildfire occurs on the far slope with natural regeneration taking place over time. Plate 4a depicts natural regeneration in the foreground (along both river banks) as a result of no management intervention. Plate 4b shows natural regeneration in the foreground after an initial salvage removal of dead trees.

Plate 4b



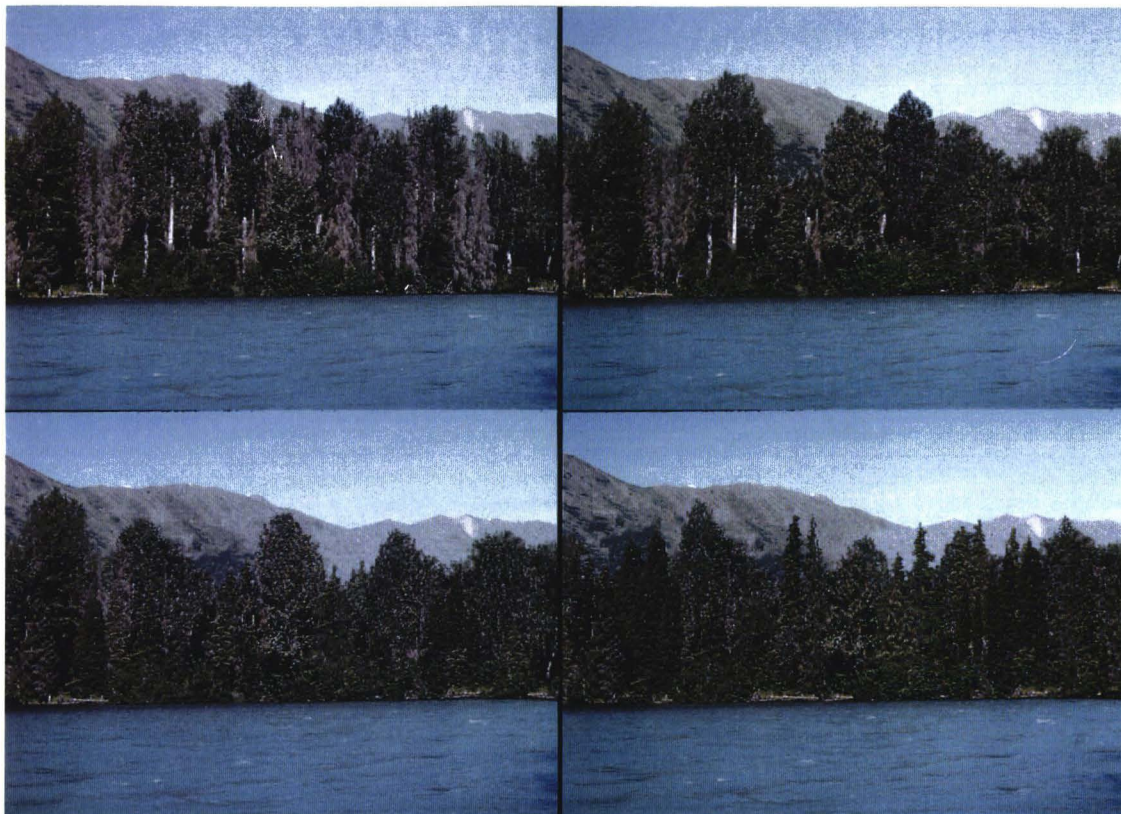


Plate 5a

Cooper Creek Campground - Scene AI 0614
5, 10, 20, 50 year scale

Simulations show conditions as the forest recovers from a spruce bark beetle outbreak. Plate 5a depicts no management intervention and natural regeneration occurs over time. Plate 5b shows natural regeneration after an initial salvage removal of dead trees.

Plate 5b

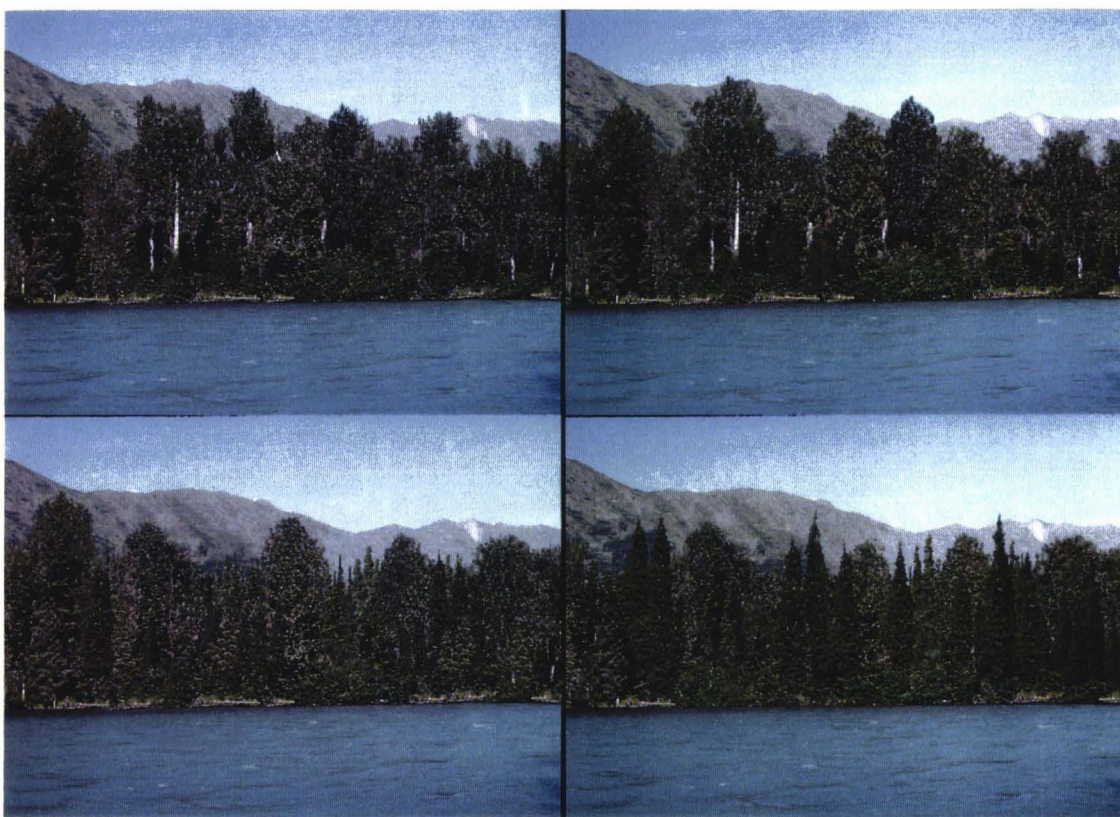




Plate 6a

Cooper Creek from Resurrection Pass Trail - Scene AI 0714
5, 10, 20, 50 year scale

Simulations show progressive changes as the forest recovers from a spruce bark beetle outbreak. Plate 6a shows natural regeneration after an anticipated wildfire. Plate 6b shows conditions after the salvage removal of dead trees on the lower slope and a controlled burn to promote natural regeneration of spruce.

Plate 6b



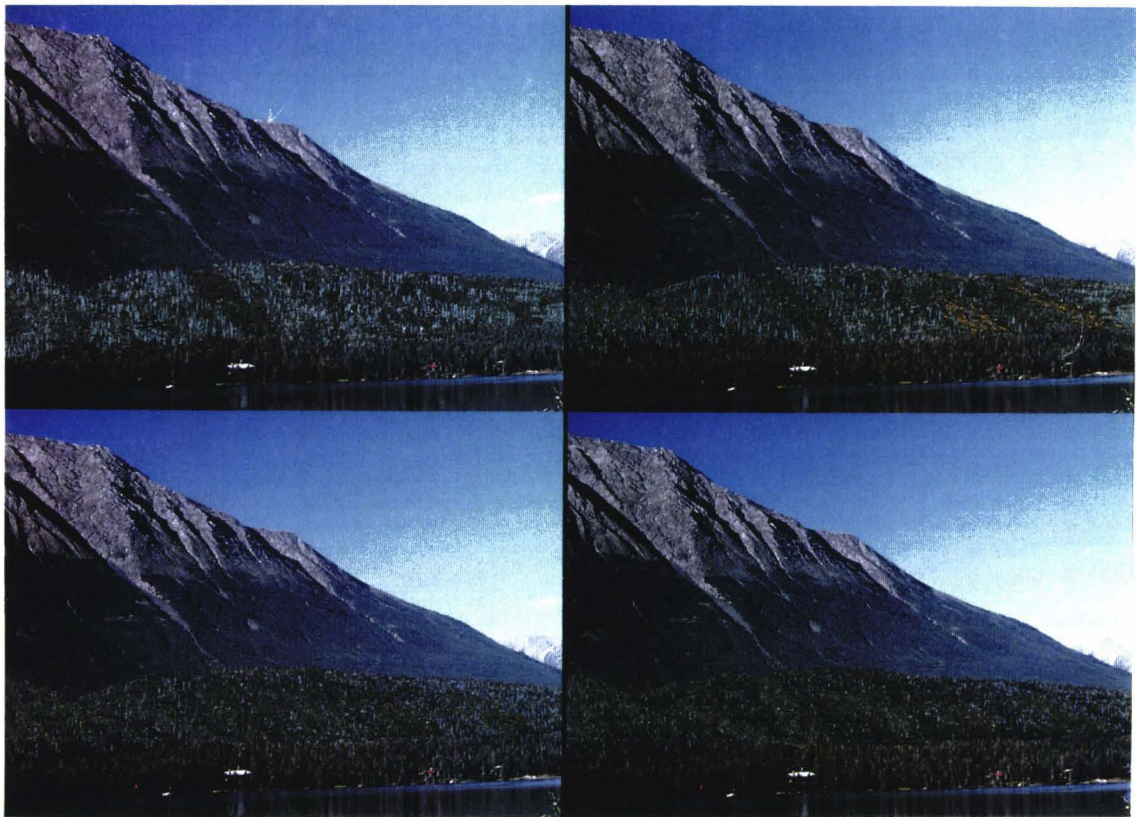


Plate 7a

Kenai Lake/Snug Harbor - Scene AI 1532
5, 10, 20, 50 year scale

Simulations show progressive changes as the forest recovers from a spruce bark beetle outbreak. Plate 7a shows natural regeneration after an anticipated wildfire. Plate 7b shows conditions after the salvage removal of dead trees and a controlled burn to promote natural regeneration of spruce.

Plate 7b

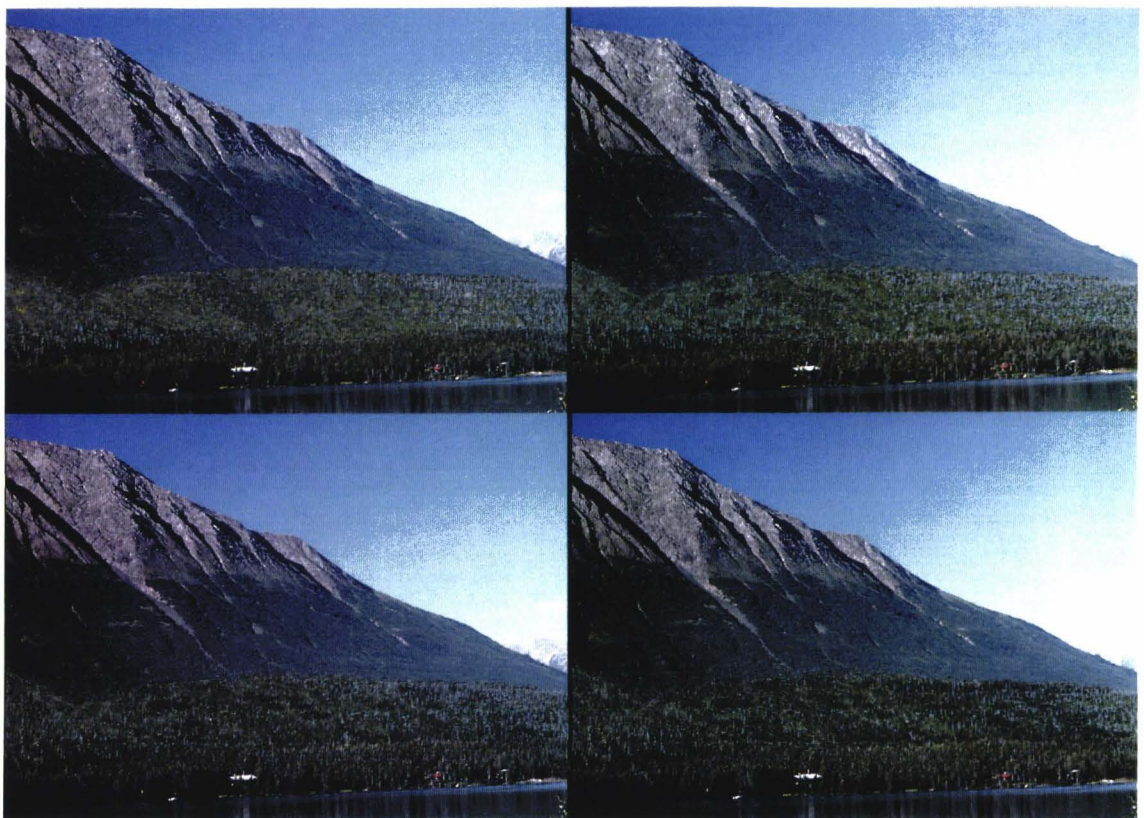


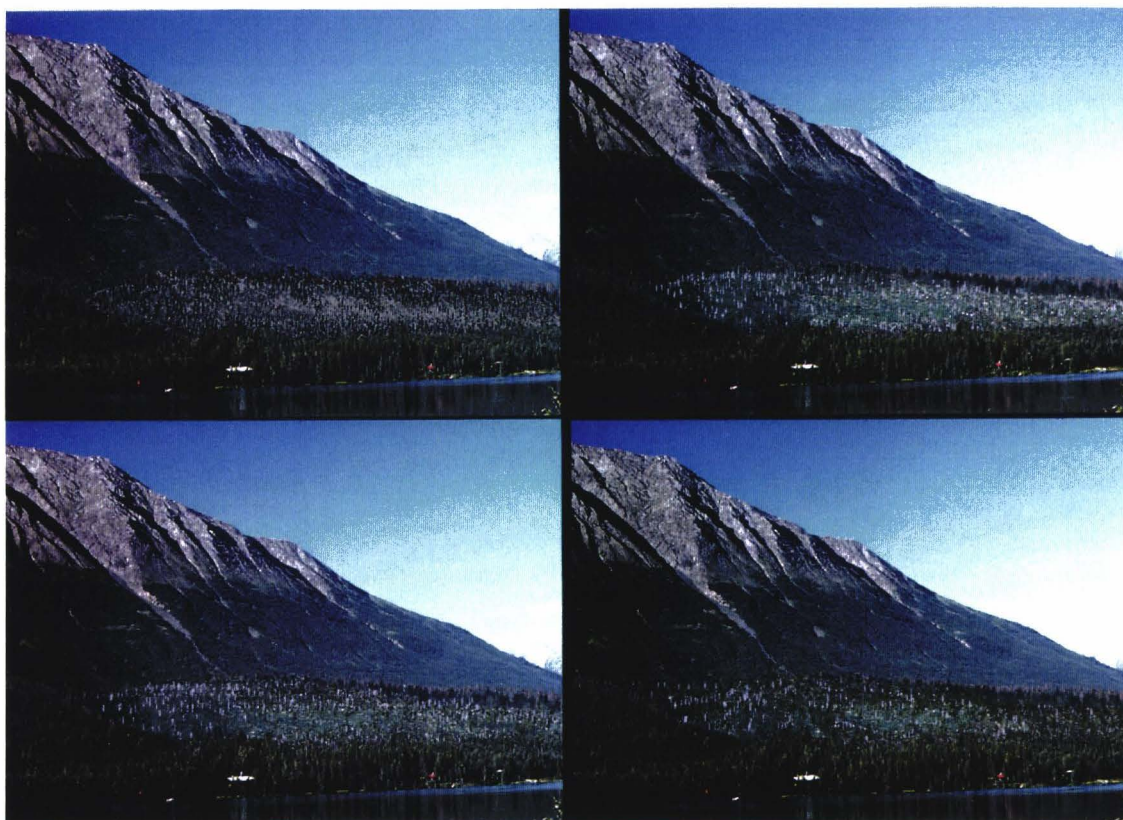


Plate 8a

Kenai Lake/Snug Harbor - Scene AI 1532
5, 10, 20, 50 year scale

Simulations show effects of prescribed burns over time. Plate 8a shows natural regeneration after cutting and burning the dead trees on site which results in a "hot" fire. Plate 8b shows natural regeneration after cutting and removing dead trees before burning which results in a fire of less intensity.

Plate 8b



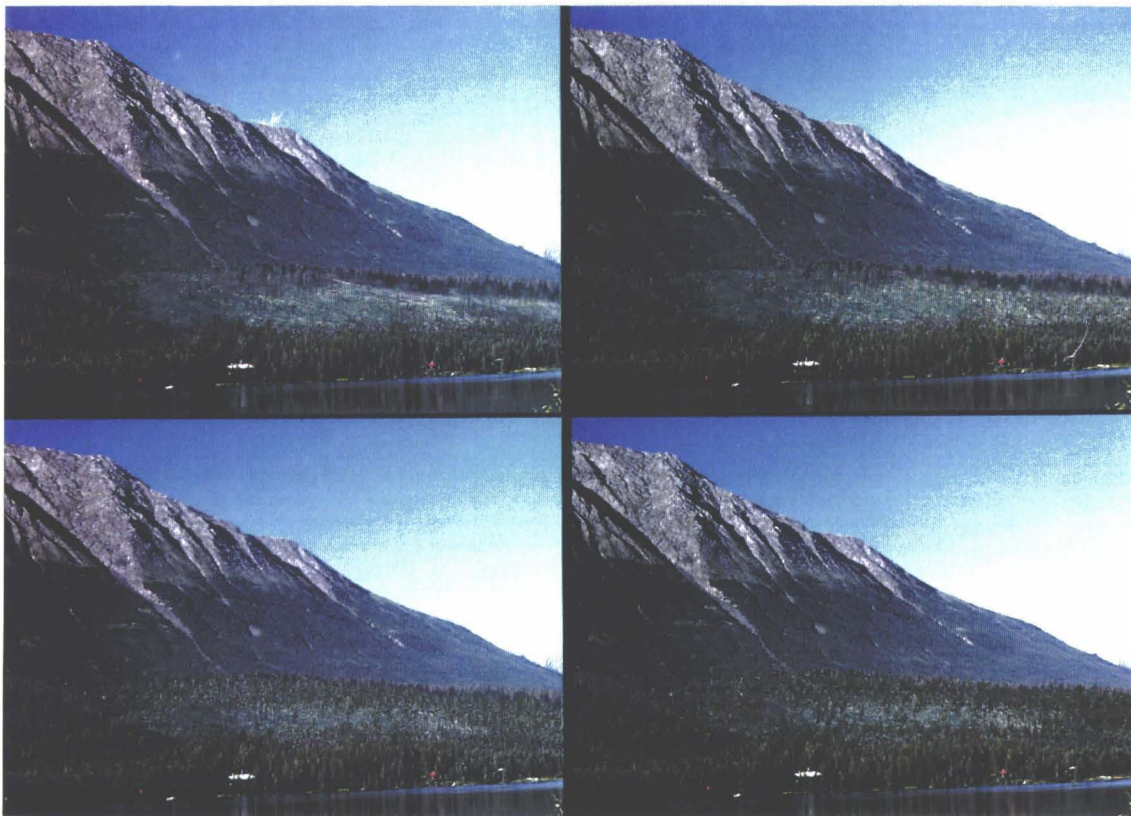
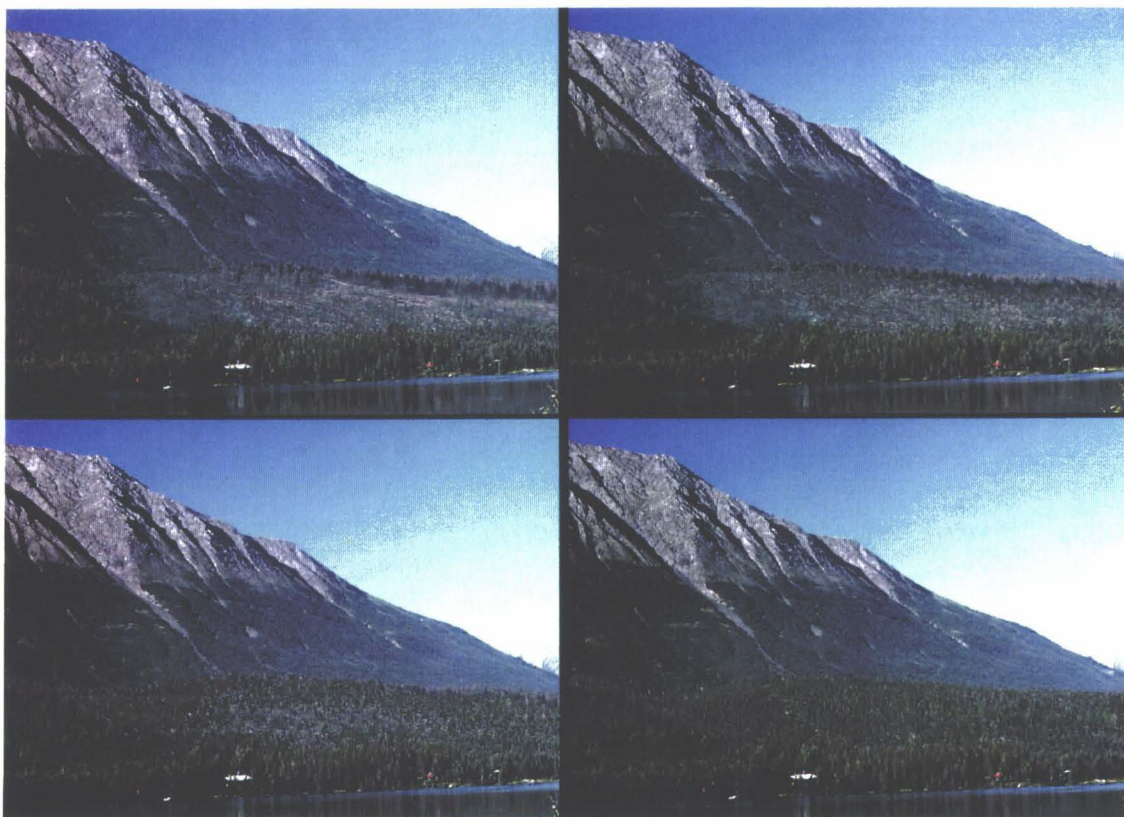


Plate 9a

Kenai Lake/Snug Harbor - Scene AI 1532
5, 10, 20, 50 year scale

Simulations show effects of site treatments following summer salvage removal of dead trees. Plate 8a shows natural regeneration after moderate ground disturbance from salvage removal operations. Plate 8b shows the effects of intense mechanical scarification after salvage removal to stimulate natural regeneration.

Plate 9b



Summary

A total of 48 digital-video simulation images were developed for the 1990 study and 24 new simulations were added for the 1991 study, resulting in 72 different simulation images. Two primary types of simulation sequences were developed: *retrospective* scenarios depicting the historic progression of bark beetle impacts over a 12 year period; and *restoration* scenarios showing alternative futures over a 50 year period following *no treatment* contrasted with one or more forest regeneration *treatment* scenarios.

All of the simulations were selected and developed in close interaction with forestry and pest management experts familiar with the Kenai Peninsula areas represented. Images were repeatedly evaluated and modified until the experts agreed that a high level of accuracy in the representation of the targeted forest conditions had been achieved. Base scenes and the simulation sequences developed for each are presented and briefly described in the preceeding color plates.

PERCEPTUAL ASSESSMENT

The simulation sequences described above formed the basis for the assessment of public perception of the effects of the bark beetle outbreak, and of possible forest management reactions. All responses in the 1990 assessment were collected in interviews with selected individual residents of, or visitors to bark beetle affected areas on the Kenai Peninsula. Two different presentation formats were used: sequences of single scenes were viewed and rated on a 10-point *scenic beauty* scale; and pairs of four-scene displays, each depicting alternative future scenarios for a given base scene, were presented and respondents were required to choose which set of future conditions provided the *best overall scenic quality*. The single scene format was repeated for color slides, prints and digital video images for different subsets of the 1990 respondents. The four-scene format was presented only in the form of color prints to a small sample in the 1990 study and to all respondents in the 1991 study.

Individual Scenes

For the single-scene format four sets of 63 forest scenes each were selected for presentation to respondents. Within each 63-scene set 51 scenes were common to all sets, and included a sample of scenes typical of the study area, as well as two retrospective "greening" sequences (four versions each of Jean Lake and Kenai Lake/South of Snug Harbor). The remaining 12 scenes were unique to each set, and were composed of a sample of the experimentally manipulated sequences (simulations of projected future conditions) for the other four base scenes.

Generally no more than three versions (simulations) of any given base scene were included in any one set of scenes, and these were always distributed among the other scenes in each presentation. Each of the 63-scene sets was organized into three different random orders, with each order being assigned randomly to individual respondents.

The goal of this "mixed" presentation procedure was to make the scene presentations as representative as possible of the conditions typically encountered by a forest visitor. On any given visit to the Kenai Peninsula study area a visitor would be expected to see a variety of different forest scenes, and to encounter several different levels of spruce bark beetle impact, but no specific scene would exhibit multiple levels of insect impact during a single visit.

Most of the participants in the 1990 study rated the *natural scenic beauty* of individual scenes representing a wide range of forest and insect damage conditions. Approximately equal numbers of participants were shown the scenes as color prints (bound in "photo-album" books), projected color slides or as displays on a video monitor. Respondents reported their judgements for each scene using a 10-point rating scale ranging from 1 (very low scenic beauty) to 10 (very high scenic beauty). Ratings were subsequently transformed to *Scenic Beauty Estimates* (SBEs), a standardized interval scale index that adjusts for arbitrary differences in the way individual respondents used the rating scale.⁵

As is typical for similar environmental perception studies, there was very high consensus in the scenic beauty ratings within each of the participant groups sampled. Internal reliability coefficients ranged from .88 to .96 (median = .93) within each of the twelve set-by-presentation medium (slides, prints, video) groups. These reliability measures estimate statistically the expected agreement between the ratings of the tested group and those of any other group that might be selected at random from the same population of respondents; perfect agreement would be indicated by a coefficient of 1.00.

No significant differences were found in ratings of the common base scenes between the different presentation sets, nor among the random orders within each set. Correlations of ratings of common scenes among the four groups of participants judging the different presentation sets ranged from .86 to .90 for visitors and from .87 to .95 for Alaska residents (again, a correlation of 1.00 would indicate perfect agreement between the groups).

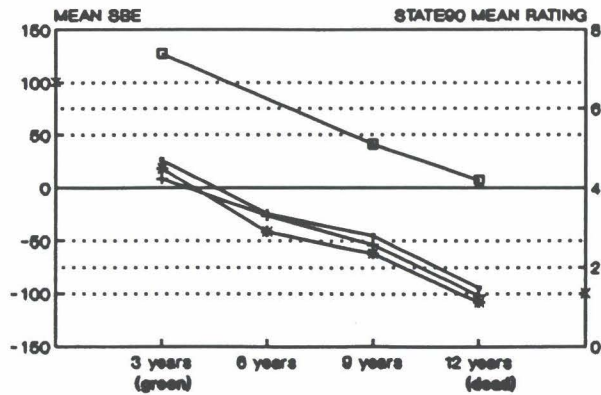
Comparison of scenic beauty judgements across the three presentation media (slides, prints and video) also indicated nearly perfect agreement. Correlation coefficients based on the ratings of the scenes that were common to all presentation sets and participant groups ($n = 43$) ranged from .93 to .97.

By all these indications there was a very high level of consensus in perceived scenic beauty among the tested groups, and a strong indication that essentially the same results would be expected for any other groups of similar people that might be assessed, as well as for alternative presentation formats. Further, there is substantial environmental perception literature confirming that public scenic beauty judgements based on color slides agree very closely with direct judgements made on-site in the depicted environments. Thus, the results of the studies reported here can confidently be generalized to the direct viewing conditions typically experienced by visitors to the represented forest areas.

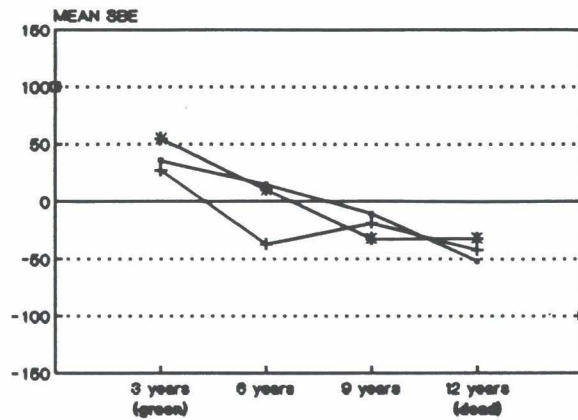
Comparison of Residents and Visitors

The scenic beauty judgements of residents and visitors were in very good agreement, regardless of the presentation format used. Overall, the correlations between resident and

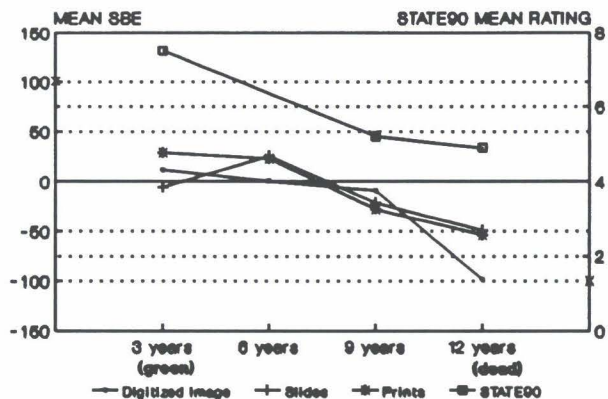
Individual Scenes - Retrospective AI1319 - Jean Lake



AI1532 - Kenai Lake/Snug Harbor



AI0617 - Kenai River/Schooner Bend



DI n=135 S n=84 P n=144 STATE90 n=103

visitor ratings was .90. As a further test of the consistency of scenic beauty judgements across different public groups, samples of undergraduate college students at the University of Arizona and the University of Illinois (most of whom had never visited Alaska) also rated the scenes. Ratings by the two college student samples were in very good agreement with each other ($r = .93$), and with the visitors sampled on-site in Alaska ($r = .89$ and $.90$ for Arizona and Illinois samples, respectively). Correlations between the student samples and the Alaska residents were somewhat lower (both $= .73$), but still indicated substantial agreement.

The Alaska State survey also included a replication of the perceptual assessment for some of the forest scenes. Color prints of 16 of the 1990 study scenes (including depictions of naturally occurring and computer simulated insect impacts) were mailed to a subset of the randomly sampled respondents, and they subsequently reported scenic beauty ratings for the scenes in a telephone interview. Ratings exactly paralleled those found in the 1990 study. Thus, scenic beauty perceptions were not only shown to be consistent between residents and visitors over different presentation formats, but they were replicated by a random sample of south central Alaska residents, justifying substantial confidence in the generality of the findings summarized in the next section.

Scenic Beauty Perceptions

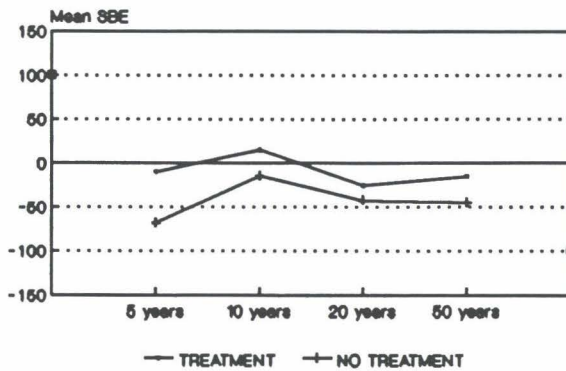
The results of the 1990 perceptual assessment, based on individual scene judgements, clearly and consistently showed that scenic beauty values declined significantly as the proportion of bark-beetle killed trees visible in the scene increased. When insect-caused mortality was

concentrated in the mid-ground of the scene (Jean Lake and Kenai River/Schooner Bend scenes, Plates 1b, 3 and 4), perceived scenic beauty decreases were especially pronounced. This pattern obtained across unaltered scenes (which included scenes with varying amounts of insect impacts), and was strongly confirmed by the judgement patterns for the simulated scenes where insect impact was systematically manipulated.

The Cooper Creek Campground scene (Plate 5) depicted a closer, more confined view including only a few bark beetle killed trees, and scenic judgements were somewhat less sensitive to the depicted changes in forest conditions. Insect effects were least noticeable in the most distant scene, the view toward Cooper Creek from Resurrection Pass Trail (Plate 6), and scenic beauty judgements were understandably less sensitive for this scene. The Kenai Lake views (/Snug Harbor and /South of Snug Harbor, Plates 2, 7, 8 and 9) evidenced intermediate levels of scenic beauty sensitivity to the beetle and forest management changes depicted.

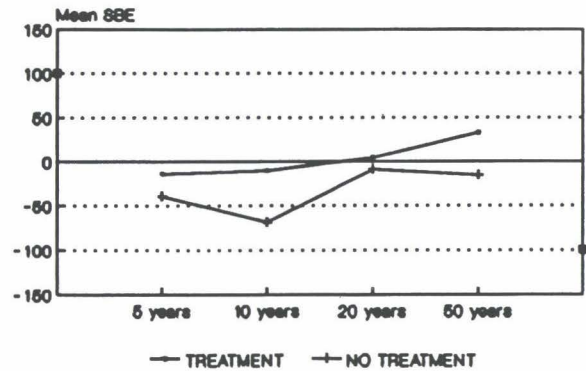
For the simulated scenarios representing the effects of various forest management actions, several major trends were revealed. First, for the retrospective infestation vs protective thinning scenario (Kenai River/Schooner Bend, Plate 3), the individual scenes depicting the expected effects of protection by *thinning* were consistently rated higher than the associated scenes from the *no treatment* scenario. Second, ratings of the scenes from the alternative restoration treatment scenarios indicated a consistent overall preference for *treatment* alternatives that accelerated recovery to forested conditions. While these trends were evident in the single-scene ratings, whether presented as video, prints or slides,

**Individual Scenes - Restoration
AI0614 - Cooper Creek Campground**



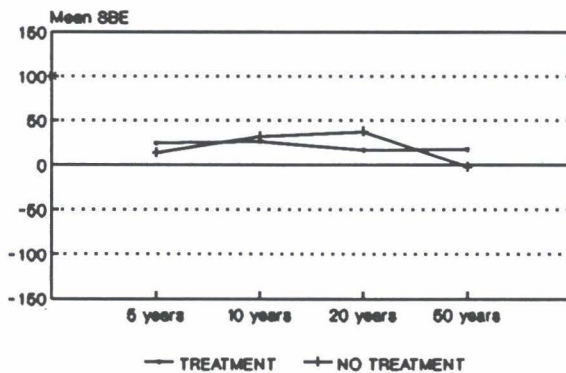
n=999

**Individual Scenes - Restoration
AI0617 - Kenal River/Schooner Bend**



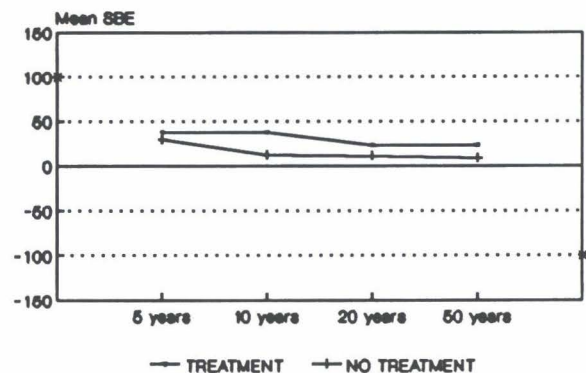
n=999

**Individual Scenes - Restoration
AI0714 - Cooper Creek/Res. Pass Trail**



n=999

**Individual Scenes - Restoration
AI1532 - Kenal Lake/Snug Harbor**



n=999

relative preferences for the various forest management alternatives were most clearly revealed in the four-scene, forced choice format discussed in the next section.

Preferred Future Forest Conditions

Some of the residents sampled in the 1990 study and all of the 1991 participants made forced choices between pairs of four-scene sets depicting future conditions expected to result from different possible forest management actions. The four-scene sets were all presented as color prints, with four individual prints arrayed on an 8 x 10 inch page. Most of the individual scenes were the same as those presented in the single-scene format discussed above.

Each of the paired sets presented two different four-scene scenarios (on facing pages of a photo-album book) for a given base scene, e.g., the scenes in Plate 3a vs those in 3b. Thus, sets were paired so that each four-scene member of a pair depicted a different "future" for a given base scene. The pairs were bound into photo-album books, with the order of pairs in each book determined by one of two random sequences. Both retrospective and future forest conditions were simulated for each base scene, as described above, and illustrated in the color Plates.

In the 1990 study, each participant made choices between *treatment* and *no treatment* restoration scenarios for each of the four base scenes. The four scenes in each set consisted of visual simulations of a given base scene as the expert panels expected it to look 5, 10, 20 and 50 years following the postulated treatment or no-treatment scenarios. For all four of the base scenes, the *treatment* scenario depicted future forest conditions expected to

result from a salvage removal of dead spruce overstory (clear cut), followed by site-preparation burning to encourage spruce regeneration. The *no treatment* scenario depicted the projected consequences of a postulated wildfire (occurring at year zero) followed by natural regeneration, resulting in predominately grass and brush with some hardwood overstory. These scene sets are presented in Plates 3 through 7.

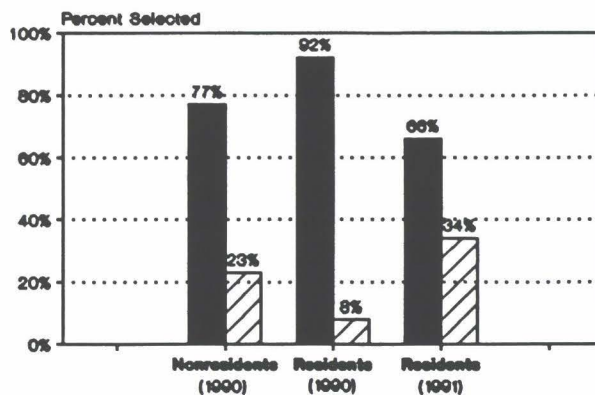
The final pair presented the two retrospective scenarios for the Kenai River/Schooner Bend scene (Plate 3). One four-scene set depicted the progressive stages of bark beetle infestation (from approximately 1978) based on historic data, with the final scene being the unmanipulated (digitized) picture of the scene with virtually all of the spruce dead (1990). The alternative four-scene set depicted the expected progression of the scene over the same years, based on the postulated 50% thinning treatment.

The results of the paired-comparisons among the four-scene sets in the 1990 study were consistent with the individual scene assessments. For the retrospective scenarios, the *thinning* option was consistently preferred over the *no treatment* infestation scenario.

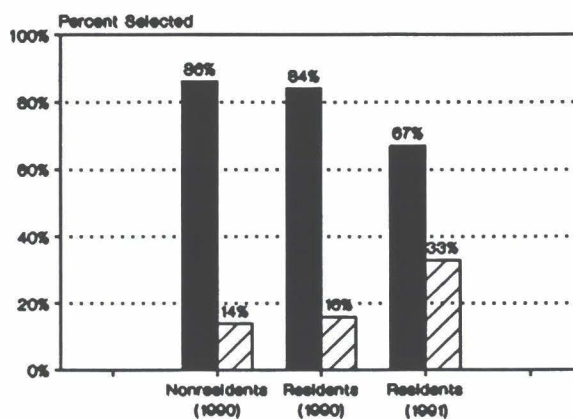
For the restoration alternatives, the *treatment* scenarios, which more quickly and completely restored a predominately spruce forest, were consistently preferred over the *no treatment* scenarios, where recovery was slower and resulted in more grass, brush and hardwoods.

The results of the 1991 paired comparisons mirrored the 1990 findings for the same scenarios. In addition, a more detailed study was conducted comparing four different management options for the Kenai Lake/Snug Harbor scene. Comparisons among the

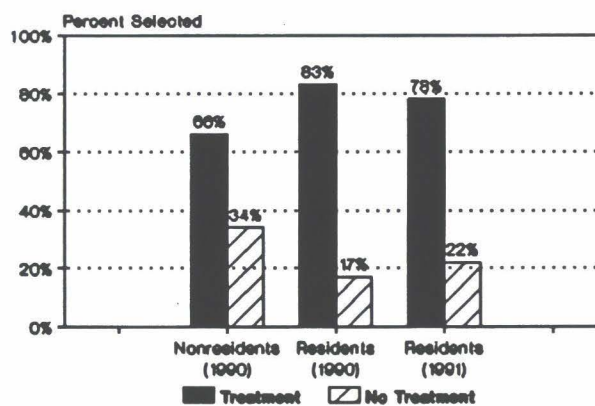
Preferred Future Forest Conditions Cooper Creek Campground



Kenai River/Schooner Bend

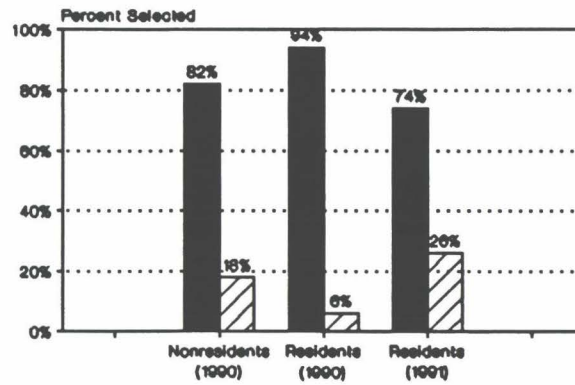


Cooper Creek from Res. Pass Trail

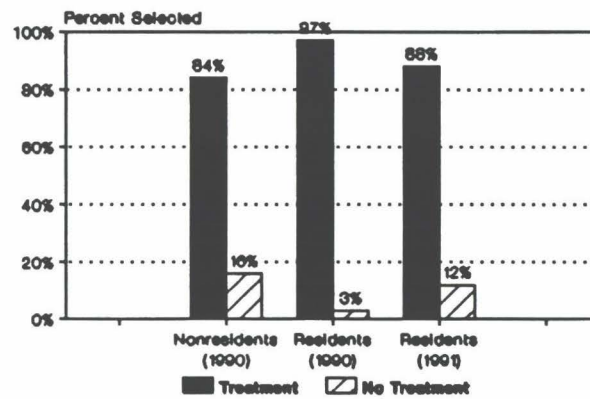


AK90 NR n=70 R n=45 AK91 n=110

Preferred Future Forest Conditions Kenai Lake/Snug Harbor

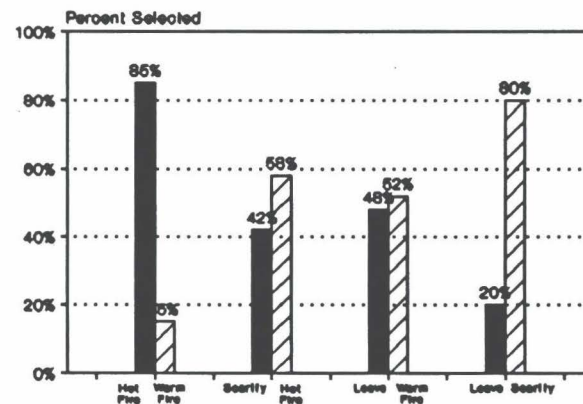


Kenai River/Schooner Bend (Retrospect.)



AK90 NR n=70 R n=45 AK91 n=109

Kenai Lake/Snug Harbor (1991)



AK91 H/W & L/S n=110 S/H n=49 L/W n=58

alternative forest restoration options, following a clearcut of the dead spruce, revealed that the strongest preference was for the *very hot fire* option (where felled dead trees were left to burn). The second most preferred option was *mechanical scarification*, followed closely by *moderately hot fire* (felled trees removed before burning), which was only slightly favored over the no-treatment *leave* option. For the one exploratory near-view scene, the *thinning protection* treatment was consistently preferred over the *no treatment* option.

Summary

The expressed preferences among the four-scene scenarios were consistent with the results of the single-scene assessments. The retrospective simulation of *thinning* spruce prior to infestation was rated higher and chosen more often than the *no treatment* option which resulted in large numbers of dead spruce. The individual scene ratings and choices among alternative restoration scenarios indicated a clear preference for *treatment* options that accelerated the recovery of forest cover, especially those, such as *hot fire* and *mechanical scarification*, that restored a significant cover of spruce. In short, respondents preferred to keep forests green if possible and, when significant numbers of trees were already dead, they preferred scenarios that featured faster recovery of forest cover, especially spruce.

An Important Caveat

While the results of the perceptual assessment were quite clear, it is important to acknowledge two important limitations on their interpretation. First, the "future forest conditions" represented in the computer simulations were based on the best available forest data and expert consensus regarding the most likely outcomes of the management alternatives considered. Still, human ability to predict complex biological processes is significantly limited, and many important factors (such as climate variations, wildfires, etc) can neither be predicted nor controlled. It follows that the specific details of the conditions depicted in the simulations represent "average" conditions based on the experts' "best estimates," and should not be viewed as absolutely certain outcomes.

Finally, the perceptual assessments pertain only to expressed preferences for the *visual* outcomes of the alternative management options evaluated. Many important issues, such as the economic costs of achieving the outcomes and the environmental consequences associated with each, cannot be directly represented by visual simulations, and these factors undoubtedly have significant effects on public reactions to forest management actions. Some of these non-visual issues were more directly addressed in the verbal portion of the assessment, described below.

ACCEPTABILITY OF ALTERNATIVE MANAGEMENT POLICIES

Following the forced-choice evaluations of alternative future forest conditions, some of the respondents in the 1990 study and all of the 1991 respondents answered questions about bark beetle-related forest management

policies. Issues addressed in this part of the assessment were identified through individual interviews with forest and pest management specialists in the US, State and local Bureau forest management agencies, local residents,

tourist facility operators and recreators and tourists visiting facilities in the study area. The specific statements and format for the assessment were evaluated and refined in a pilot test on a sub-set of the 1990 respondents.

The management policy section of the assessment was introduced by a general description of the life cycle of the spruce bark beetle and how it attacks and kills trees. The outbreak on the Kenai Peninsula was described, including an oblique aerial photograph of a severely affected area just north of the Kenai River near Cooper Landing.

The policy assessment was divided into five sections, each preceded by a brief description. Individual sections included questions pertaining to the acceptability of management policies in different contexts, including:

1. **general policies** regarding whether to allow the outbreak to follow its natural course or to actively try to stop it;
2. **prevention** of the conditions that may lead to outbreaks;
3. **protection** of trees in threatened areas once an outbreak is already underway;
4. **restoration** of forest areas that have already been severely affected by an outbreak; and
5. questions pertaining to **expectations** regarding the future spread of the current Kenai Peninsula outbreak.

A copy of the complete assessment instrument, including introductory information and instructions is provided in the attached Appendix to this report.

General Policies

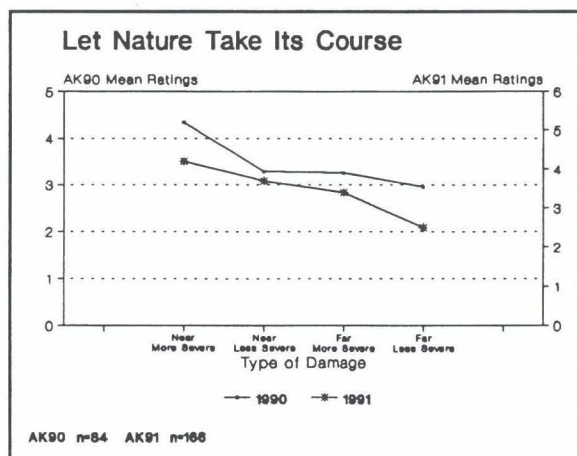
This section sought to determine in general the circumstances under which respondents would favor not taking any explicit management action in response to the bark beetle infestation. The introductory statement for this section was:

One response to the spruce bark beetle outbreak is to accept it as a natural process and to just "let nature take its course." In remote areas this may be the only possible response. In some Parks and Wilderness Areas it may be the only alternative allowed by law. Where managers have a choice, the best policy is to let nature take its course, so long as the area is:

Four situations were described which differed in the severity of the beetles' effects on the forest and where the effects occurred relative to human developments. *More severe* effects were represented as areas where most of the spruce trees would be killed and "only grass and brush is expected to grow back." *Less severe* effects specified less tree mortality and that "new trees are expected eventually to grow back." The location of the effects was described as *near* or *far away* from homes and recreation areas.

For both residents and visitors in the 1990 study, and for the residents in the 1991 study, the greatest willingness to **let nature take its course** was for areas described as *far away* from developments where damage was described as *less severe*. There was split agreement and disagreement for this policy in *far away/more severe* and *near/less severe* conditions. The majority of respondents disagreed strongly with the **let nature take its course** policy for areas *near* developments

where damage was described as *more severe*.



Prevention Before an Outbreak

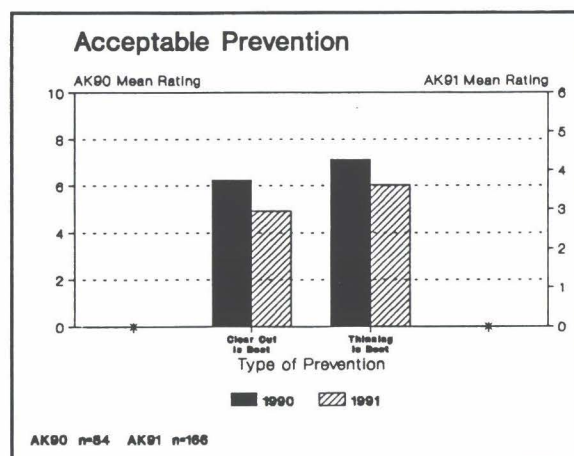
This section focussed upon actions that might be taken in forest areas that are not currently infested, but are threatened by bark beetle infestation. In particular, this section addressed the acceptability of vegetation management options, such as thinning or clear cutting susceptible spruce stands.

The text that introduced this section was:

One method for protecting forest areas that are threatened by the bark beetle outbreak is to remove about half of the trees. This is intended to reduce the number of places for the beetles to breed and to help the remaining trees grow more vigorously so that they are better able to resist beetle attacks.

There was substantial agreement that removing some trees (about 50%) is an effective and acceptable method for protecting threatened stands. Consistent with the Alaska State survey, residents in both the 1990 and 1991 studies indicated that *thinning* was the

most preferred method for tree removal. In both studies there was generally less agreement with *clear cutting small patches*, though about 22% of the 1990 resident sample rated this option as "completely acceptable," and 15% of the 1991 sample "strongly agreed" with this approach.



Respondents in the 1991 study agreed that *cut trees should be sold to private companies*, and that cutting and revegetation treatments should be implemented even if *selling the trees will only pay for part of the costs*.

Protection During an Outbreak

The focus of this section was on forest areas currently involved in an active bark beetle infestation. Based on available pest management options in these circumstances, the only management alternative offered was to spray insecticides. The questions posed addressed the particular conditions under which various spraying policies would be approved.

The introductory statement was:

During a bark beetle outbreak it is possible to protect selected trees by spraying environmentally approved insecticides directly on the bark. Spraying costs about 5 to 10 dollars per tree and lasts for up to three years.

The use of insecticides, even when presented as "environmentally approved," produced very divided responses. The 1990 study yielded a pattern of widely split opinion, with slightly more residents finding insecticide spraying "completely acceptable" (21%) as compared to "completely unacceptable" (14%). Visitors showed a much stronger pattern for this question, with only 2% indicating completely acceptable and 30% completely unacceptable. In the 1991 study 44% strongly or moderately agreed vs 30% strongly or moderately disagreeing that insecticides *are perfectly safe for use around homes and recreation areas*; the middle 25% tended more to mild agreement.

Interestingly, the Alaska State survey found a pattern of greater acceptability for *encouraging property owners to use insecticides* the farther the respondent was from the affected sites; there was 65% approval by residents in the affected areas, 72% by residents of other (unaffected) Kenai Peninsula areas, and 80% by Anchorage residents. At the same time, only 39% of Kenai residents favored the use (by the State) of insecticides to protect trees in campgrounds. The indication is that insecticide use evokes strong reactions, and involves more than one dimension of public concern.

The more detailed pattern of responses provided by the 1991 study indicated that insecticides were generally accepted as the most effective protection method. Defining

"agreement" as a rating of 1 through 4, and "disagreement" as ratings 7 through 10), a larger proportion (47%) of 1991 respondents agreed that *spraying insecticides is the best way to protect large trees*, with 36% disagreeing. Only 22% agreed that spraying makes trees *essentially 100% safe from bark beetle attack* vs 42% who disagreed. Objections to insecticides were based on their potential harm to *other insects and animals* (40% vs 30%) and because they are *potentially dangerous to humans* (42% vs 30%). At the same time 57% indicated they would be *willing to use environmentally approved insecticides to protect important trees near your home* as apposed to 31% who would not.

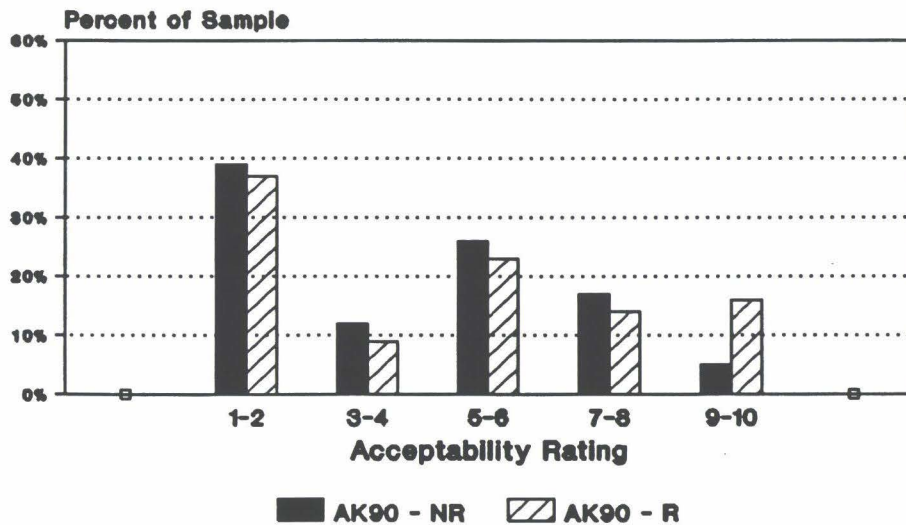
Restoration After an Outbreak

For many parts of the Kenai Peninsula the primary concerns are no longer prevention or even protection, but **restoration** of large areas of forest already severely affected by the bark beetle infestation. The introduction to this section of the policy assessment stated:

After a major beetle outbreak, a primary concern for forest areas that are frequently visited or seen by people is with how to treat the large areas of dead trees. Often more than 90% of the spruce trees are dead. New spruce trees need bare soil and sunlight to get started, and they need protection against competing grasses and brush for the first few years. The best treatment for beetle-affected forest areas is:

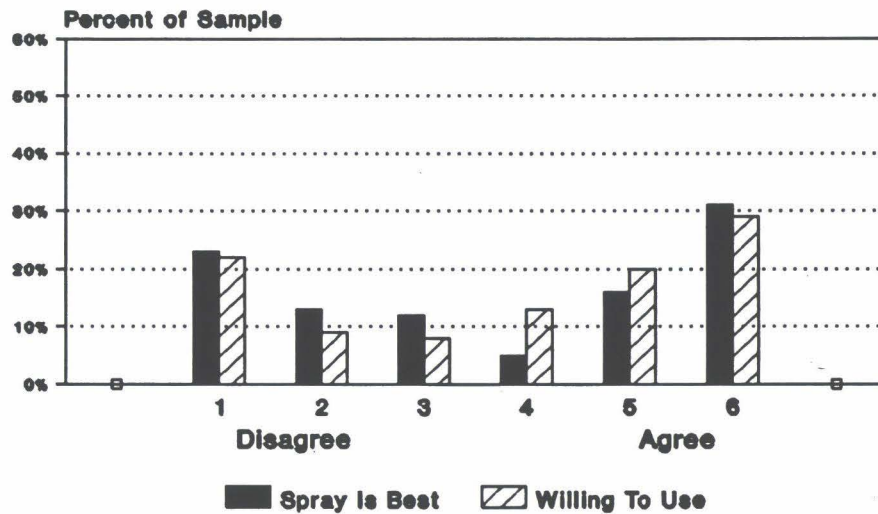
Options offered in this context included methods of dealing with the large numbers of dead trees (*leaving the forest undisturbed*,

Protection During An Outbreak 1990 Sample



R n=84 NR n=67

Protection During An Outbreak 1991 Sample



AK91 n=166

cutting and leaving or cutting and removing the dead trees), and with alternative methods of regenerating the forest. Alternatives for getting new trees to grow on affected sites primarily involved reducing competition from grass and brush by use of fire, very hot or moderately hot, scraping the ground bare in some areas (mechanical scarification) or applying environmentally approved herbicides.

In the 1991 study there was strong support for "doing something," as apposed to leaving bark beetle affected areas untreated. Less than 1% strongly agreed with a policy of *leaving the forest undisturbed, and allowing it to recover as best it can*. This result is consistent with responses to the *allow nature to take its course* options in the 1990 study and as repeated in the General Policy section of the 1991 study, where treatment of severely damaged areas near developments was consistently strongly favored. *Cut, remove and burn* was the most popular restoration option for Alaska residents in both the 1990 and 1991 studies. In response to a similar set of options, 77% of Kenai Peninsula residents participating in the Alaska State survey favored *cutting and removing the dead trees*, and 67% favored *cutting, burning and revegetating damaged areas along highways*, compared to 29% favoring *leave them as is*.

For areas near homes only 13% of Kenai residents favored the leave as is option. Thus, residents in all three studies generally favored cut and burn options for rehabilitating stands, especially when the trees are removed prior to the burn. Danger of wildfire was not a sufficient reason to preclude burning for most 1991 respondents, 47% disagreed with the policy that burning *should not be allowed because of the danger of starting wildfires* vs 31% who agreed.

Reactions to the herbicide options, like those to insecticide spraying, were widely split with about as many strongly agreeing as strongly disagreeing. In the State survey respondents preferred scraping or the use of mats (an option not offered in either the 1990 or 1991 studies) over chemical treatment (herbicide), whether used with or without fire. Only 23% of 1991 respondents agreed that the side effects of burning *have as bad an effect on the environment as herbicides*, while 44% disagreed. There was, however, a strong split in opinion regarding a complete prohibition against the use of herbicides; 26% of respondents strongly agreed that *herbicides should not be used under any circumstances*, matched by another 26% who strongly disagreed with that prohibition.

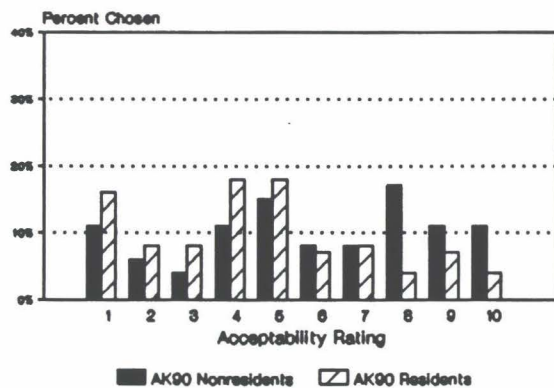
Expectations

This final section of the policy acceptability assessment addressed expectations for the future spread of the bark beetle outbreak. The goal of this section was to determine the extent to which respondents perceived the outbreak as a continuing threat, and whether they believed it might have serious consequences for their own communities. The context for this part of the assessment was set by:

The spruce bark beetle outbreak has now affected over 200,000 acres on the Kenai Peninsula. Biological surveys indicate that the outbreak may be continuing to spread.

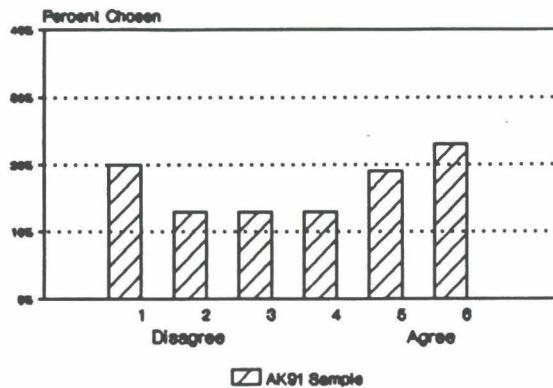
Three statements that followed addressed the likelihood of the outbreak spreading to *other areas on the Kenai Peninsula, to the area where you live* and the expected severity of effects should the outbreak spread, *you would not expect more than half of the spruce trees to be lost*.

Restoration - Cut/Leave/Burn - 1990



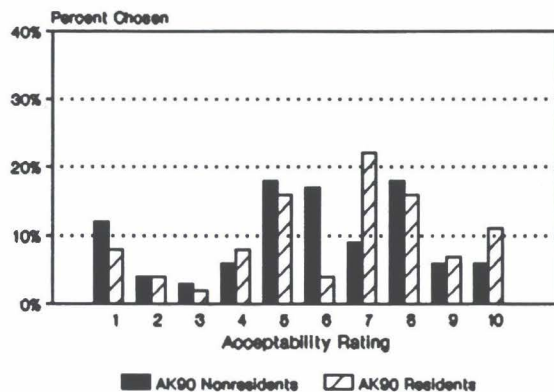
NR n=66 R n=44

Restoration - Cut/Burn - 1991



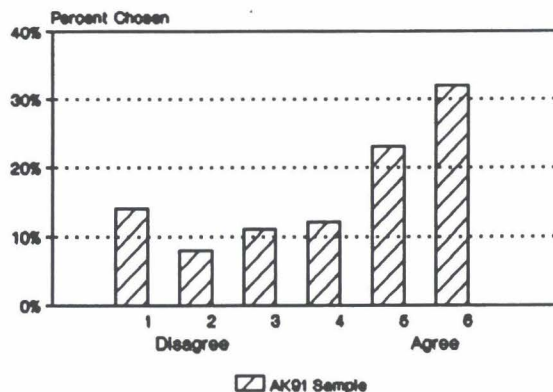
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Restoration - Cut/Remove/Burn - 1990



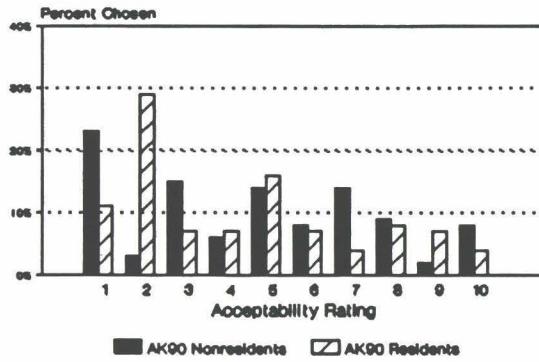
R n=45 NR n=66

Restoration - Cut/Remove/Burn - 1991



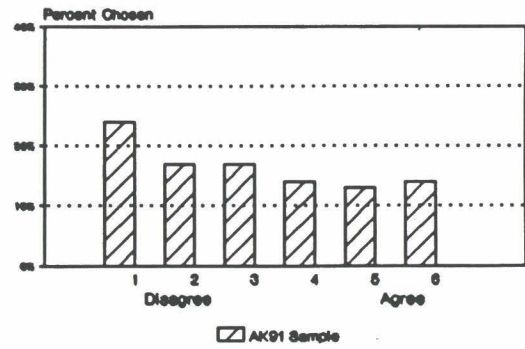
n=73

Restoration - Cut/Scrape - 1990



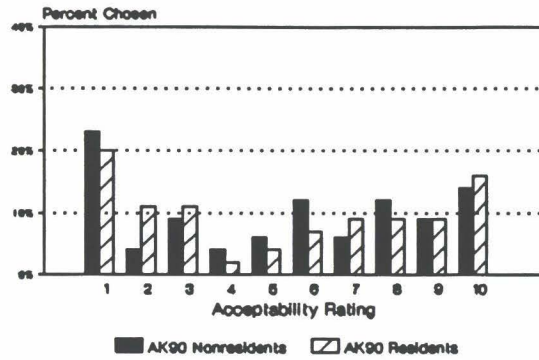
R n=45 NR n=66

Restoration - Cut/Scrape - 1991



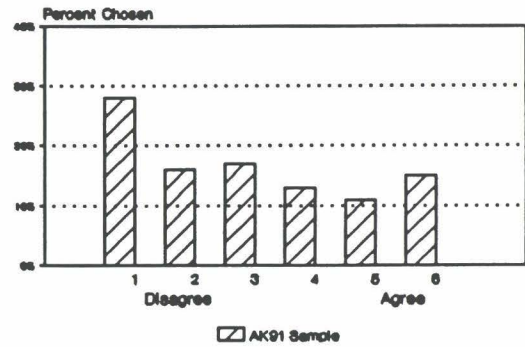
n=66

Restoration - Cut/Herbicide - 1990



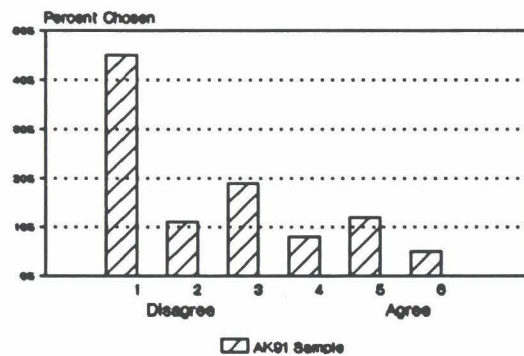
R n=44 NR n=66

Restoration - Cut/Herbicide - 1991



n=75

Restoration - Leave Undisturbed - 1991

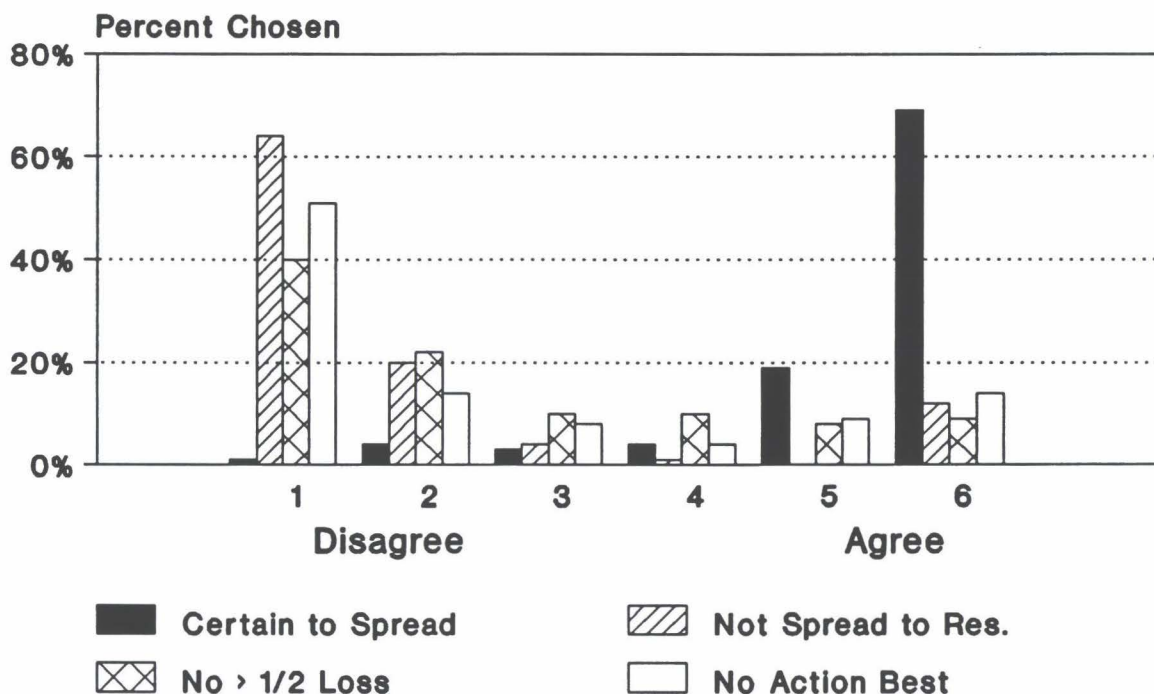


n=75

The residents sampled in the 1991 study were quite certain that the outbreak *will continue to spread* (89% agreed), that it *will spread to their own properties* (83%), and that

substantial damage will result when it does spread to their area; 62% agreed that *at least half of spruce trees will die* in affected areas.

Expectation of Future Conditions 1991 Sample



n=73

The final statement in the assessment attempted to reach the "bottom line:" *All things considered, you would rather allow most of the spruce trees in your area to be killed by bark beetles than to have the forest treated by cutting and spraying insecticides.*

Overall, 66% of the residents sampled in 1991

disagreed with the policy indicated by this statement.

Summary

A number of consistent policy preferences emerged across the two studies reported. First, there was agreement that some

management intervention is preferable to "letting nature take its course," especially for areas near developments when damage is severe. The most preferred *prevention* treatment was *thinning* (about 50%) stands in threatened areas, with *clear cutting small patches* garnering less support.

The only *protection* option offered was spraying approved insecticides, which produced strongly divided responses. The majority of residents in both the 1990 and the 1991 studies were almost equally split between strong agreement and strong disagreement. This split pattern was repeated for the associated items referring to the effectiveness and safety of insecticide use. Visitors in the 1990 study tended to more strongly oppose the use of insecticides.

There was much greater consensus regarding *restoration* options. Generally, there was strong agreement across studies and respondent groups that some active rehabilitation effort should be undertaken in areas of severe beetle damage, and the *cut, remove and burn* alternative was consistently preferred over other options. As with insecticide use, the application of herbicides met with responses that were approximately

equally split between strong agreement and strong disagreement; the majority of the 1991 respondents were divided equally between strong agreement and strong disagreement with a complete ban on the use of herbicides.

The observed relationships between the observed patterns of support and non-support for alternative forest management policies and the perceptual preferences expressed by the same groups of respondents reveals a potential dilemma. The forest conditions most preferred in the perceptual assessment--where possible, retain green forests dominated by mature spruce, or where damage has already occurred, re-establish green spruce as quickly as possible--are most readily achieved by management policies that were the least acceptable, or that resulted in strongly split opinion, such as the application of insecticides or herbicides. Thus, the future forest conditions most consistently preferred perceptually may be in conflict with the management options most consistently preferred for achieving those conditions. The next section directly addresses the relationships between individual respondent's preferred perceptual *ends*, and their support for the implied management *means*.

PREFERRED ENDS VS ACCEPTABLE MEANS

The conflict between preferred future forest conditions and acceptable management strategies noted above is based on comparisons among average responses over all respondents. Even with this overall pattern of conflict it is possible that individual respondents could hold consistent perceptual and policy preferences; those who strongly prefer green forest conditions might be more tolerant of management practices required to

achieve and maintain those conditions, and *vice versa*.

To further investigate this important relationship, and to further articulate the patterns of agreement and disagreement with the management policies assessed in the 1991 study, a **factor analysis** was conducted.⁶ This analysis allows the discovery of consistent patterns of responses across the different

policy questions, and provides a better basis for determining the relationships between individual perceptual and policy preferences.

Policy Factors

The analysis revealed several important "factors," defined by consistent patterns in respondents' support (or non-support) for specific sets of management policies. By far the strongest factor (accounting for 37% of the variation in respondents' reactions to the policies offered) was defined by the degree of support (or non-support) for the use of insecticides and herbicides. Respondents scoring high on this *chemical treatment* factor tended to support the use of insecticides and herbicides, while those scoring low on the factor tended to be opposed to such treatments. The high end of this factor was associated with strong disagreement (and the low end by strong agreement) with the policies of:

...leaving the (damaged) forest undisturbed; and

...allow most of the spruce trees in your area to be killed by bark beetles (rather) than have the forest treated by cutting and spraying insecticides.

At the same time, the *chemical treatment* factor was characterized by stronger agreement (disagreement) with policy statements relating to the use of insecticides for protecting threatened forest areas:

Spraying insecticides is the best way to protect large trees near homes...;

Trees that are sprayed with approved insecticides are essentially 100% safe from bark beetle attack;

Environmentally approved insecticides are perfectly safe...; and

I would be willing to use environmentally approved insecticides...;

while disagreeing (agreeing) with statements that

Insecticides should not be used ... because other insects and animals might be harmed; and

... approved insecticides should not be used because they are potentially dangerous to humans.

With regard to rehabilitation of forest areas already damaged, this factor was defined by stronger agreement (disagreement) with

cutting and removing the dead trees and applying environmentally approved herbicides,

and disagreement (agreement) with

Herbicides should not be used under any circumstances because of possible contamination of the environment.

Following the *chemical treatment* factor were four much weaker factors, which achieved minimal statistical criteria for consideration. The second factor (explaining 14% of variance) also involved the degree of support for chemical treatment options, but was primarily defined by the degree to which the continuing bark beetle outbreak was perceived as a *threat*. Respondents contributing high scores on this factor tended to support chemical treatments, but judged that there was little threat that the bark beetle outbreak would actually continue to spread. The high end of the *threat* factor was associated with stronger agreement that:

There is very little chance that the bark beetle outbreak will spread to the area where you

live; and

... if the outbreak does spread to your area, you would not expect more than half of the spruce trees to be lost .

In addition, the *threat* factor included agreement with statements indicating that insecticide spraying is 100 % effective for protecting threatened trees, and removing trees (e.g., thinning) is not effective. For rehabilitation cutting and removing dead trees and applying herbicides is preferred, while burning is judged to have as bad an effect on the environment as herbicides, and burning should not be allowed because of the danger of starting wildfires.

The third factor (explaining 13% of variance) was complex, defined by agreement (disagreement) that the outbreak was *certain to spread* coupled with disagreement with "allowing nature to take its course" (except when damage was *less severe* and *far away* from developments). This factor was also associated with preferences for rehabilitating damaged areas by *cut, remove and scrape* treatments and by opposition to burning because of the *danger of starting wildfires*.

The fourth and fifth factors were very weak (explaining 9% and 7% of variance, respectively), but do suggest other patterns of response to the policy options assessed. Factor four was characterized by agreement that the outbreak was *certain to spread*, coupled with support for protecting threatened forest areas by *clear cutting small patches* and for cutting trees on public lands *even if selling the trees will only pay for part of the costs*.

The final factor, which had minimal statistical power, was defined by acceptance that the outbreak will spread to the respondent's area

and will do substantial damage (indicated by disagreement with *little chance that the bark beetle outbreak will spread*, and with *not expect more than half of the spruce trees to be lost*), but a willingness to let nature take its course *near to homes and recreation areas, even when the damage to the forest is more severe*. For areas already severely damaged, the rehabilitation option associated with this factor was *cutting and removing the dead trees and then burning the site with a moderately hot fire*.

Relationships with Perceptual Preferences

To be consistent, respondents whose expressed perceptual preferences indicated a desire to keep threatened spruce forests green, or to have beetle impacted forests restored quickly, should have also supported forest management actions that can effectively achieve those ends (e.g., preventative cutting, insecticide spraying and herbicide use). Alternatively, individuals who disagreed with these forest management approaches should have been more accepting of the visual impacts of bark beetle infestations in forest scenes. To investigate these relationships individual respondent's scores on the management policy factors described above were related to their perceptual preferences as expressed in the four-scene forced choice section of the assessment.

An aggregate measure of perceptual preferences was computed for each respondent as the percentage of choices in which the *treatment* scene-set was selected over the *no-treatment* set. This measure of preference for treatment-produced forest conditions was related in a multiple linear regression analysis to the five management policy factors described in the preceding section.

Factor Loadings by Policy Item *

Item #	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
1	.001	-.042	.045	.171	-.166
2	-.134	.024	-.433	.252	.070
3	-.142	-.028	-.403	.305	.216
4	-.157	.176	-.452	.149	.506
5	.145	-.098	.331	.279	.023
6	.012	.402	-.069	.063	-.104
7	.210	.190	.258	.386	-.205
8	-.061	.208	.263	-.069	.293
9	.259	.177	.126	.194	-.086
10	.291	-.178	.084	.430	-.037
11	.054	.203	.109	.187	.148
12	.761	.135	-.094	-.189	-.071
13	.558	.453	-.055	.033	.117
14	.698	.249	-.183	.090	.058
15	-.639	.149	.235	.245	-.039
16	.794	.097	-.063	.053	-.026
17	-.259	.051	.114	.044	.128
18	-.767	.117	.106	.145	-.075
19	.418	.062	.126	.112	.211
20	.336	-.058	.128	.296	.383
21	-.036	.244	.415	-.078	.053
22	.504	.401	.085	-.034	.187
23	-.606	.174	-.268	.070	.040
24	-.724	.015	.198	.074	.221
25	-.395	.487	.229	-.262	.125
26	-.285	.484	.396	-.063	.018
27	.241	-.277	.434	.398	-.043
28	-.023	.581	-.200	.114	-.284
29	-.058	.398	-.246	.213	-.361
30	-.628	.097	-.228	.227	-.054

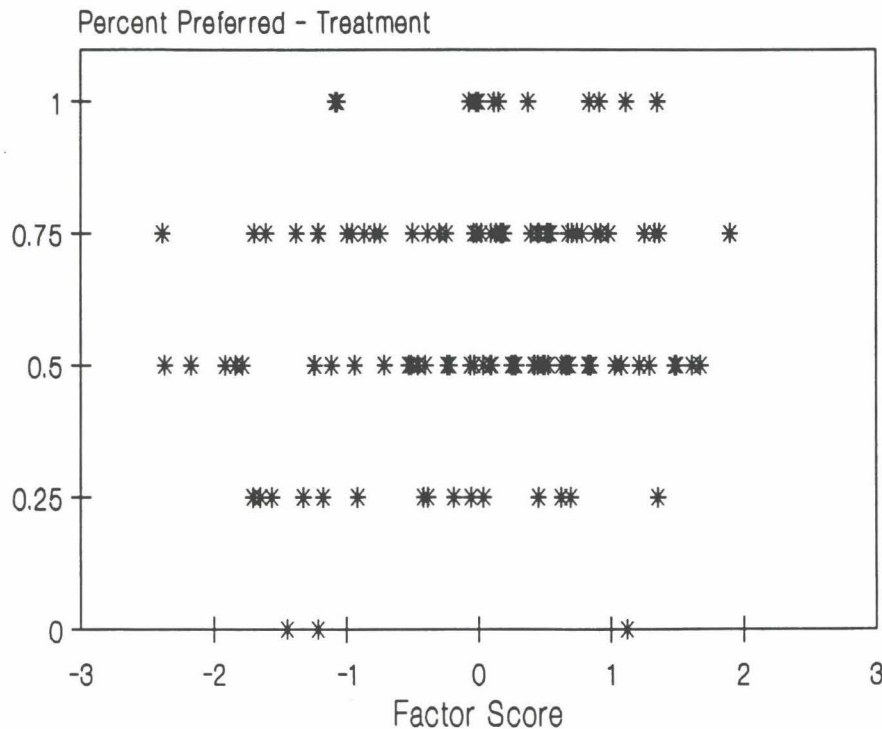
* Complete text for Items In attached Appendix.

The analysis revealed no statistically significant relationships between individual's perceptual preferences and their support (or non-support) for any of the management policy factors, individually or in combination. That is, preferences for the perceptual *ends* were independent of the acceptance of the management *means* most likely to achieve those ends. Further analysis also revealed no consistent differences among the respondent groups sampled (the various Kenai Peninsula resident groups participating in the study) in either perceptual preferences, support for the policy factors or in the relationships between perceptual preferences and patterns of policy support.

Summary

Factor analysis of the agreement and disagreement with the various forest management policies assessed revealed several coherent patterns. The strongest pattern was represented by the *chemical treatment* factor. The high end of this factor was defined by higher levels of support for active forest treatments, particularly for the use of insecticides and herbicides, which were accepted as safe and effective methods for prevention, protection, and restoration of the forest. The *chemical treatment* factor provided the strongest divisions among the Kenai Peninsula and Anchorage residents who

Perceptual Preferences vs. Chemical Treatment Factor



participated in the 1991 study, but each community represented in the study had effectively equal numbers of individuals at each end of this scale.

The other policy support patterns discovered in the analysis were considerably weaker. A *threat* factor was primarily characterized at the high end by the judgement that the bark beetle outbreak would not spread and would not have very serious consequences if it did. Respondents who scored high on the third factor tended to accept the bark beetle outbreak as a continuing threat, but restricted their support of forest rehabilitation actions to

mechanical scarification because of a fear that burning would start wildfires.

The final two factors were both defined by acceptance of the bark beetle as a continuing threat, but those scoring high on the first of these factors tended to support logging as a management approach (including clear cutting and selling trees at a loss), while the weaker of these last two factors was associated with the willingness to accept the consequences of the outbreak and to allow nature to take its course. As for the first factor, there were no consistent patterns of differences among the communities sampled in their scores on these factors.

CONCLUSIONS

The spruce beetle outbreak on the Kenai Peninsula was almost universally recognized as a serious problem by residents of the area. *Increased fire danger* and *loss of scenic beauty* were identified as the most important effects of the bark beetle infestation. Most respondents believed that the outbreak will continue to spread and that their own properties will be significantly affected.

For tourists and visitors to the affected areas sight-seeing was by far the most frequent activity, and the quality of natural scenery was consistently reported as the most important factor affecting their enjoyment of their trip. Clearly, the visual impacts of the bark beetle outbreak are of great concern to both residents and visitors to the Kenai Peninsula, and should be a key consideration in any forest management decisions for the area.

Perceptual Preferences

The assessment of the perceived effects of the beetle outbreak on forest scenery, based primarily on computer video simulations, revealed several consistent patterns. First, whether presented as color slides, color prints or as video images, the greater the proportion of beetle killed trees in a forest scene the lower the rated scenic beauty. This pattern obtained for residents and visitors alike. Second, a hypothetical preventative thinning treatment was consistently preferred to a (retrospective) no treatment infestation scenario which allowed virtually all of the spruce to die. Finally, for forest areas where bark beetle impacts were already severe, respondent's preferred the visual conditions produced by rehabilitation strategies that

resulted in more rapid regeneration of forest cover.

The consistency of responses from different respondent groups (residents, visitors and two college student samples), and between the different presentation media employed, strongly supports the conclusion that the results of the perceptual assessments provide a valid basis for predicting the perceptions of residents and visitors who view similar forest scenes directly. The visual impacts of the spruce bark beetle outbreak do significantly affect the quality of resident and visitor experience.

Support for Management Alternatives

The acceptability of alternative forest management responses to the bark beetle outbreak were assessed separately by a series of verbal statements. In areas likely to be seen or visited by people, areas near homes and developed recreation areas, the majority of residents in both the 1990 and the 1991 studies preferred some form of treatment over "allowing nature to take its course." The particular treatment options preferred depended upon the stage of the outbreak.

Prevention in threatened areas: The preferred treatment was to thin threatened spruce stands (by approximately 50%). This preference obtained even though respondents understood that large trees should be taken first and that the costs of treatment (which should include replanting trees) might exceed the revenues likely to result from selling the cut trees.

Protection during an outbreak: Opinion was

most divided here, especially with regard to the possible roles of insecticide spraying. At one extreme were individuals who viewed sprays as less than 100% effective, potentially harmful to animals and dangerous to people. Based on these views, they disagreed with use of "environmentally approved insecticides." None-the-less, many of these same respondents indicated that they would use insecticides to protect high valued trees on their own property. At the other extreme was a group of respondents who agreed that sprays are "the best method" for protection. However, many of these respondents did not believe sprays to be "100% effective," and they tended to be divided on whether spraying was "too expensive for most private property owners."

Restoration after an outbreak: The clear message here was **Do Something!** Preferred actions included cut and remove dead trees (even if selling them will recover only part of the costs), then burn the site to aid in the re-establishment of a spruce forest. Danger of wildfire caused by site preparation burning was generally not viewed as a sufficient concern to preclude fire as a treatment option. Scraping the ground was not widely accepted as a regeneration method, though it did appeal to a minority who were concerned that burning treatments might cause wildfires. The use of herbicides, paralleling the results for insecticide spraying, produced wide splits in opinion, and herbicides were generally less preferred than burning.

Ends vs Means

The analysis of individual respondent's perceptual preferences and the management policies they supported revealed no significant relationships. Perceptual preferences and support for management policy options were

assessed separately, so the visually presented *ends* were never directly associated or paired with the management *means* which they most likely implied. This opportunity to "have your cake and eat it too" is not unlike the situation created by most of the public participation activities typically associated with forest management planning.

In the "real world," of course, any given set of forest conditions is necessarily associated with a particular, limited set of management options--forest condition ends are generally not separable from their forest management means. In the context of the spruce bark beetle outbreak on the Kenai Peninsula, for example, the combination of maintaining a dense mature spruce forest and adopting a policy of "allowing nature to take its course" is not a realistic option.

In bark beetle threatened areas, cutting some of the spruce trees now (thinning or patch cutting) may be the only cost-effective way to prevent all the trees from being lost later. The use of insecticides and herbicides is clearly controversial and can be relatively expensive. However, chemical treatments are often the only viable means of protecting threatened high-value trees in campgrounds and near residences, or of insuring regeneration of spruce on important sites where forests have been destroyed by bark beetle infestation.

Implications for Management

The assessment studies reported here, along with the results of the Alaska State telephone survey, provide important insights into public perceptions and values regarding Kenai Peninsula forests and forest management policies. Residents are acutely aware of the bark beetle outbreak, and they expect it to

continue to spread. Residents and visitors alike are perceptually sensitive to the visual impacts of the bark beetle outbreak, and they are concerned with an array of scenically-based forest values that may be adversely affected.

The highest level of concern is for severely affected forests near residential and recreation developments. Any forest management strategy that is responsive to public values and concerns must address visual impacts of the spruce bark beetle outbreak. At the same time, many forest management actions themselves have visual impacts (especially vegetation management alternatives) which must be taken into account; it is important that the management "cure" not produce visual effects that are worse than the bark beetle "disease."

There is a general consensus that some active forest management response is needed and desired. However, there is considerably less consensus regarding what that response should be. Respondents were particularly divided on the acceptability of using insecticides to protect threatened forest stands or of using herbicides to help regenerate spruce on stands already heavily damaged.

There was inconsistency between the perceptually preferred future forest conditions and the acceptability of forest management practices most likely required to achieve those conditions. This inconsistency derives in part from the fact that perceptual and management policy preferences were assessed separately. There was also an indication, however, that respondent's knowledge and/or beliefs about the various management options may not be sufficient for them to make meaningful means-ends trade offs. For example, a significant number of respondents did not believe that

insecticides can provide complete protection (for a three year period) against bark beetle attack. Also, even though both were described as "environmentally approved," significant numbers of respondents apparently were not convinced that insecticides or herbicides are safe. If chemical treatments are thought to be less effective and less safe than they actually are, it is unlikely that the public could properly assess their relative costs and benefits as responses to the bark beetle outbreak.

Overcoming the means-ends dilemma will require attacks on several fronts. First, a concerted "environmental education" effort directed at the concerned publics would seem to be indicated. This would require that the scientific community, in and outside the Forest Service and forestry professions, reach a consensus on the effectiveness and safety of chemical treatment options for protecting beetle-threatened forest stands and for regenerating stands already impacted. Then, this consensus must be effectively communicated to the public. Second, the public should be presented with meaningful forest condition-management policy options; in effect they must be allowed to choose among future forest conditions packaged together with the management policies required to achieve those conditions.

Future Research Directions

Computer visual simulation technology was demonstrated to be very effective in communicating the important visual impacts of the spruce bark beetle outbreak. Visualizations also provided concrete comparisons with the visual effects of alternative management actions that might be required to protect or rehabilitate affected forest stands. Respondents were willing and,

apparently quite able, to make consistent choices among alternative future forest conditions that involved changes over as much as a 50-year time period.

Responses to the verbally presented management alternatives produced consistent and coherent patterns of response; the *chemical treatment* factor provided the strongest basis for distinguishing among respondent's policy choices. However, there were no consistent relationships between the perceptual *ends* that were preferred and support for the management *means* most likely required to achieve the desired forest conditions.

Based on the outcomes of the two studies reported here, additional efforts are indicated in two important areas. First, visual simulations of alternative future forest conditions should be improved by strengthening the links between forest data, both from inventories and as projected by

biological models, and the detailed features of the digital video image representations of those data. Data visualization technology is improving very rapidly, and more refined and consistent algorithms for translating quantitative data into concrete visual representations are being developed. Of equal importance to valid visual simulations are efforts to improve the biological bases for more precisely predicting future forest conditions, including details of the spatial and temporal distributions of projected forest changes.

Second, better formats should be developed for presenting visual simulations together with descriptions and other information about the forest management activities that the achievement and maintenance of those conditions imply. The metric conjoint analysis paradigm⁷ and mathematical modeling techniques developed within the marketing research and consumer decision analysis fields offer promising approaches in this regard.

FOOTNOTES

- ¹ State of Alaska, Department of Natural Resources, Division of Forestry (1992) *Forest health management plan for the western Kenai Peninsula and Kalgin Island*. 40 p.
- ² Daniel, T.C., B. Orland, A. Lynch, J. Hetherington and J. La Fontaine (1990) Integration of GIS and video imaging technology for data-driven visual simulations. In J. Greer (Ed.) *Protecting natural resources with remote sensing*. American Society for Photogrammetry and Remote Sensing, Bethesda, MD, 1990.
- ³ Kruse, J. and R. Pelz (1991) *Developing a public consensus on the management of spruce bark beetle on the Kenai Peninsula*. Institute of Social and Economic Research, University of Alaska, Anchorage, AK, 36 p.
- ⁴ Orland, B. (1988) Video imaging: a powerful tool for visualization and analysis. *Landscape Architecture*, 78(4), 78-88.

Orland, B. (1991) Digital image processing aids for visual simulation of forest management practices. In T. Daniel and I. Ferguson (Eds.) *Integrating research on hazards in fire-prone forest environments*, US Man and the Biosphere Program, US Department of State, Washington, DC. 73-83.
- ⁵ Daniel, T.C. and R.S. Boster (1976) *Measuring landscape aesthetics: the Scenic Beauty Estimation Method*. USDA Forest Service Research Paper RM 167, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 66 p.
- ⁶ Gorsuch, R.L. (1983) *Factor analysis*, 2nd Edition, Hillsdale, NJ: Lawrence Earlbaum Associates.
- ⁷ Louviere, J.J. (1988) *Analyzing decision making: metric conjoint analysis*. Sage University Paper series on Quantitative Applications in the Social Sciences, Beverly Hills, CA: Sage Publications. 95 p.

Appendix

Copy of 1991 Assessment Instrument

Environment Perception Assessment Alaska



ENVIRONMENT PERCEPTION LABORATORY
UNIVERSITY OF ARIZONA

IMAGING SYSTEMS LABORATORY
UNIVERSITY OF ILLINOIS

ENVIRONMENT PERCEPTION ASSESSMENT

The purpose of this study is to investigate public perceptions of the effects of the spruce bark beetle outbreak on the Kenai Peninsula, and to determine what forest management actions are most acceptable to residents of beetle-affected or beetle-threatened areas.

Forests in Alaska are important for many reasons--wildlife, timber, oil and minerals, wilderness and outdoor recreation, and natural scenic beauty to name only a few.

In this study we are interested in the publics' perceptions of the spruce bark beetle outbreak on the Kenai Peninsula. In some places the beetles have already killed most of the trees, and the question is how the affected forests will recover. In areas where the beetle outbreak is now threatening to spread, the question is whether we should attempt to protect the forest and, if so, how.

Responding to the bark beetle outbreak requires the cooperation of a number of federal, state and local government agencies as well as many private land owners. The beetles do not recognize jurisdictions or property boundaries.

It is very important, therefore, that the perceptions and concerns of people who live, work and recreate in the affected areas be considered in decisions about how to respond to the beetle outbreak.

This booklet presents sets of pictures showing how several forest areas could look in the future. The pictures were created with the help of a computer. The conditions shown are based on information about forest conditions and growth patterns, including the effects of bark beetles and forest management actions. You will be asked to judge which of the forest conditions shown you would most prefer. There will also be some questions about the effects of the bark beetle outbreak and about some of the possible ways of dealing with it.

Thank you very much for your help.

FOREST RECOVERY AFTER BEETLE ATTACK

The following sets of pictures show how bark beetle-attacked areas in Kenai Peninsula forests could look in the future. The areas shown have all been affected by the spruce bark beetle outbreak, and now over 90% of the spruce trees are dead.

Pictures are arranged four to a page in this pattern:

5 YR	10 YR
20 YR	50 YR

Each page shows how the scene would be expected to look **five, ten, twenty** and **fifty years** in the future if certain forest management actions were taken. Each forest area is represented by two pages of scenes, each depicting the expected results of a different forest management approach. Actions might range from simply allowing nature to take its course (no action) to cutting and removing all of the dead trees and planting a new forest. Several of the pages show the effects of fire, either "prescribed" fire used as a management tool, or wildfire.

Some actions result in poorer results in the short term, but better results in the longer term. Other management options may do better in the short term, but not so well in the longer term.

There are fourteen pairs of scene pages. Each pair shows the expected results of two different management actions for the same forest area. We are interested in your judgement of which page of scenes in each pair represents the **best overall scenic quality**.

Please quickly look through all of the pages of scenes, then evaluate each pair of pages one at a time. For each pair, select which page (**A** or **B**) represents the best overall results for the forest area shown.

Record your choice for each pair by circling the appropriate letter (**A** or **B**) on the answer sheet provided.

PROTECTING THREATENED FOREST AREAS

All of the sets of scenes in the previous pages showed views of forest areas that have already been severely affected by spruce bark beetles. The following two pairs of scene sets show possible future conditions for two forest areas that are just beginning to be attacked by beetles.

As in the previous pages, the scenes represent conditions **3, 6, 9 and 12 years** in the future. In the two forest areas shown, most of the spruce trees are currently alive and uninfested by bark beetles. However, both areas are in the path of a spreading beetle outbreak.

Pictures are arranged four to a page in this pattern:

3 YR	6 YR
9 YR	12 YR

The set of four scenes on each page shows how one forest area is expected to look in the future as a result of taking particular management actions now. Possible actions range from allowing the beetle outbreak to take its own course, perhaps only cleaning up dead and fallen trees later, to thinning out some of the threatened trees and spraying some with environmentally approved insecticides.

Please look at the scenes and then select the page in each pair which represents the **best overall visual quality**. As for the previous sets, mark your choices on the answer sheet by circling the letter (A or B) to indicate which page in each pair provides the best overall visual results.

FOREST MANAGEMENT APPROACHES

On the following pages are 30 statements regarding different aspects of the spruce bark beetle outbreak on the Kenai Peninsula and possible forest management responses. Please read each statement and determine how much you would agree or disagree with it.

Record your answers on the answer sheet provided, by marking the appropriate box from

Strongly Agree to **Strongly Disagree**

The statements are divided into five sets. Each set of statements is preceded by a short introduction.

One response to the spruce bark beetle outbreak is to accept it as a natural process and to just "let nature take its course." In remote areas this may be the only possible response. In some Parks and Wilderness Areas it may be the only alternative allowed by law. Where managers have a choice, the best policy is to let nature take its course, so long as the area is:

- | | |
|---|---|
| 1. far away from homes and recreation areas, but only when the damage to the forest is less severe, and new trees are expected to eventually grow back in the area. | 3. near to homes and recreation areas, but only when the damage to the forest is less severe, and new trees are expected to eventually grow back in the area. |
| 2. far away from homes and recreation areas, even when the damage to the forest is more severe, and only grass and brush is expected to grow back in the area. | 4. near to homes and recreation areas, even when the damage to the forest is more severe, and only grass and brush is expected to grow back in the area. |

One method for protecting forest areas that are threatened by the bark beetle outbreak is to remove about half of the trees. This is intended to reduce the number of places for the beetles to breed and to help the remaining trees grow more vigorously so that they are better able to resist beetle attacks.

- | | |
|---|---|
| 5. Bark beetles prefer to attack larger more mature spruce trees, so it is best to remove the larger trees first. | 9. When trees are removed to protect public forests from beetles, the cut trees should be sold to private companies. |
| 6. Removing trees from beetle-threatened areas is generally not effective in protecting the remaining trees. | 10. Managers should cut trees on public lands to help protect beetle-threatened forests, even if selling the trees will only pay for part of the costs. |
| 7. Clear cutting small patches is the best way to remove trees and protect spruce forests. | 11. If trees are to be cut on public lands, all logging roads should be closed and disturbed areas should be replanted. |
| 8. Thinning, by removing a few trees here and there, is the best way to remove trees and protect spruce forests. | |

During a bark beetle outbreak it is possible to protect selected trees by spraying environmentally approved insecticides directly on the bark. Spraying costs about 5 to 10 dollars per tree and lasts for up to three years.

- | | | | |
|-----|--|-----|---|
| 12. | Spraying insecticides is the best way to protect large trees near homes and important recreation areas. | 16. | I would be willing to use environmentally approved insecticides to protect important trees near my home. |
| 13. | Trees that are sprayed with approved insecticides are essentially 100% safe from bark beetle attack. | 17. | Spraying approved insecticides to protect trees from beetles is too expensive for most private property owners. |
| 14. | Environmentally approved insecticides are perfectly safe for use around homes and recreation areas. | 18. | Approved insecticides should not be used because they are potentially dangerous to humans. |
| 15. | Insecticides should <u>not</u> be used to protect trees from bark beetles because other insects and animals may be harmed. | | |

After a major beetle outbreak, a primary concern for forest areas that are frequently visited or seen by people is with how to treat the large areas of dead trees. Often more than 90% of the spruce trees are dead. New spruce trees need bare soil and sunlight to get started, and they need protection against competing grasses and brush for the first few years. The best treatment for beetle-affected forest areas is:

- | | | | |
|-----|--|-----|--|
| 19. | cutting down the dead trees and then burning the site with a very hot fire to clear the ground and kill competing grass and brush. | 21. | cutting and removing the dead trees and mechanically scraping the ground bare in some areas to temporarily reduce competing grass and brush. |
| 20. | cutting and removing the dead trees and then burning the site with a moderately hot fire to partially clear the ground and temporarily reduce competing grass and brush. | 22. | cutting and removing the dead trees and applying environmentally approved herbicides to temporarily reduce competing grass and brush. |

- 23. leaving the forest undisturbed, and allowing it to recover as best it can.
- 24. Herbicides should not be used under any circumstances because of possible contamination of the environment.

- 25. Burning produces smoke and other by-products that could have as bad an effect on the environment as herbicides.
- 26. Burning forest sites should not be allowed because of the danger of starting wildfires.

The spruce bark beetle outbreak has now affected over 200,000 acres on the Kenai Peninsula. Biological surveys indicate that the outbreak may be continuing to spread.

- 27. It is almost certain that the outbreak will spread to other areas on the Kenai Peninsula.
- 28. There is very little chance that the bark beetle outbreak will spread to the area where you live.

- 29. Even if the outbreak does spread to your area, you would not expect more than half of the spruce trees to be lost.
- 30. All things considered, you would rather allow most of the spruce trees in your area to be killed by bark beetles than to have the forest treated by cutting and spraying insecticides.

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